Engineering
OCT 14 1943

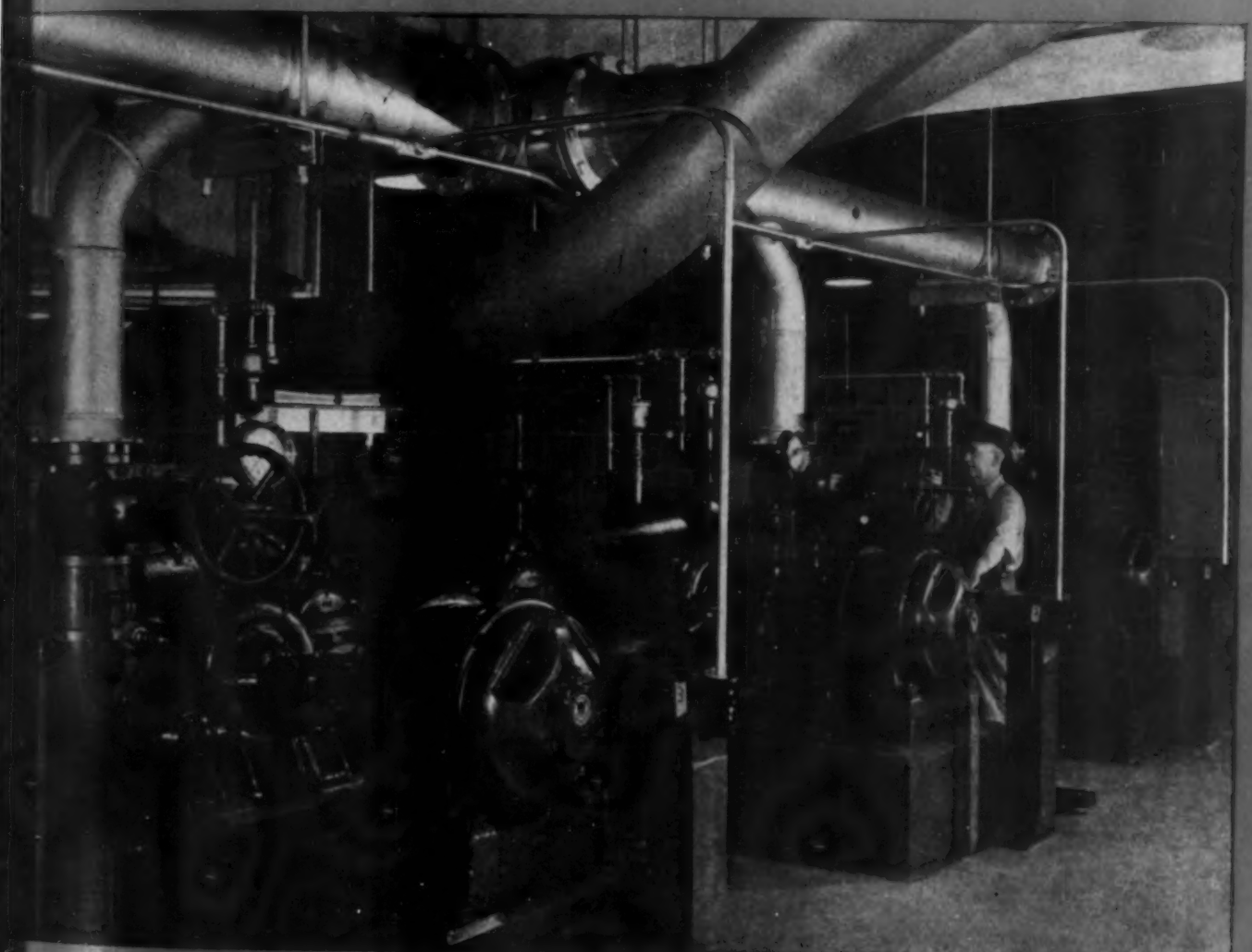
Heating Piping & Air Conditioning

DESIGN
INSTALLATION
OPERATION
MAINTENANCE

OCTOBER ★ 1943

INDUSTRIAL
COMMERCIAL
AND LARGE
BUILDINGS

545: *Journal Section of the American Society of Heating and Ventilating Engineers*



Preventive maintenance programs keep heating, piping, and air conditioning equipment on the job.

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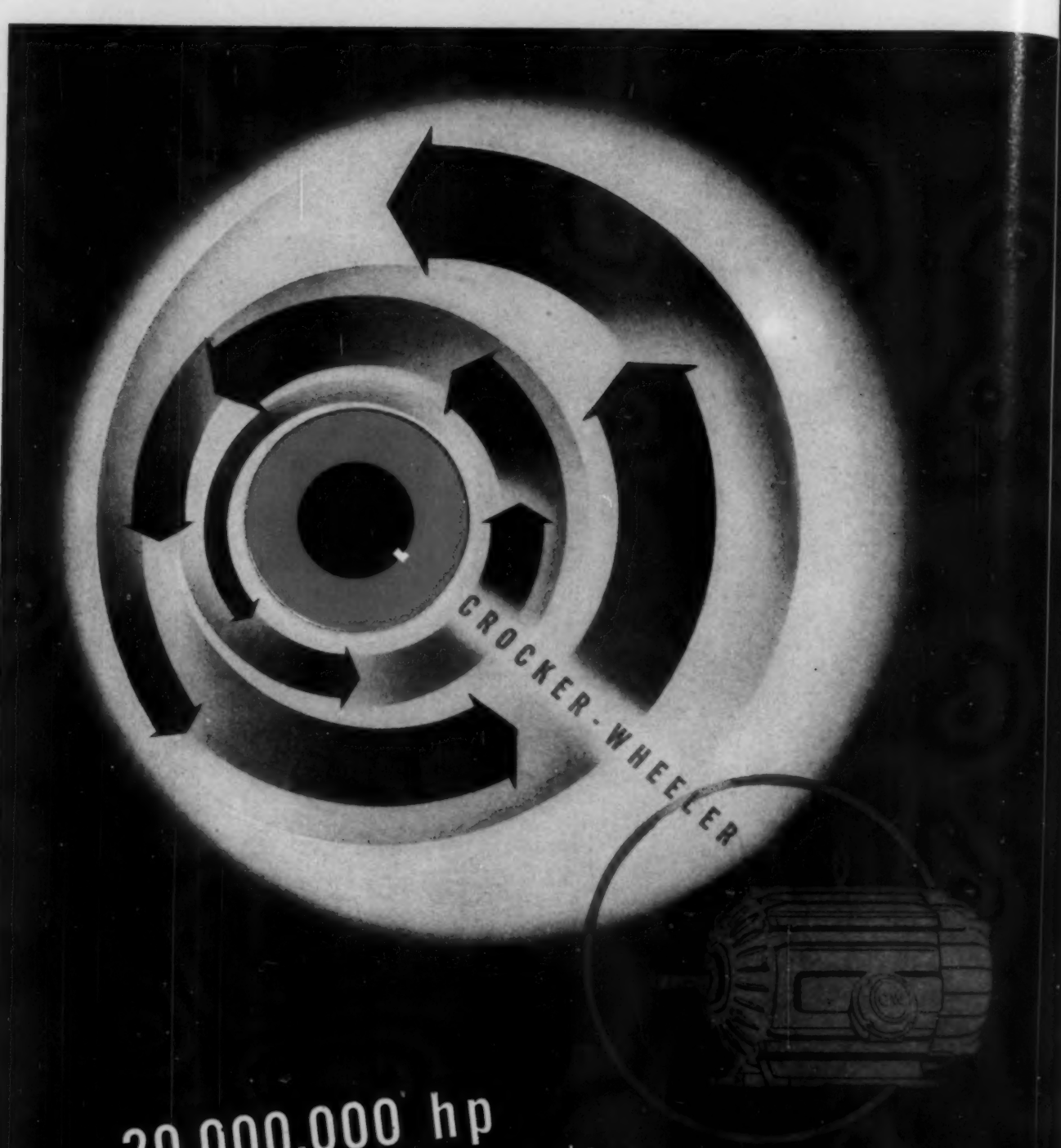

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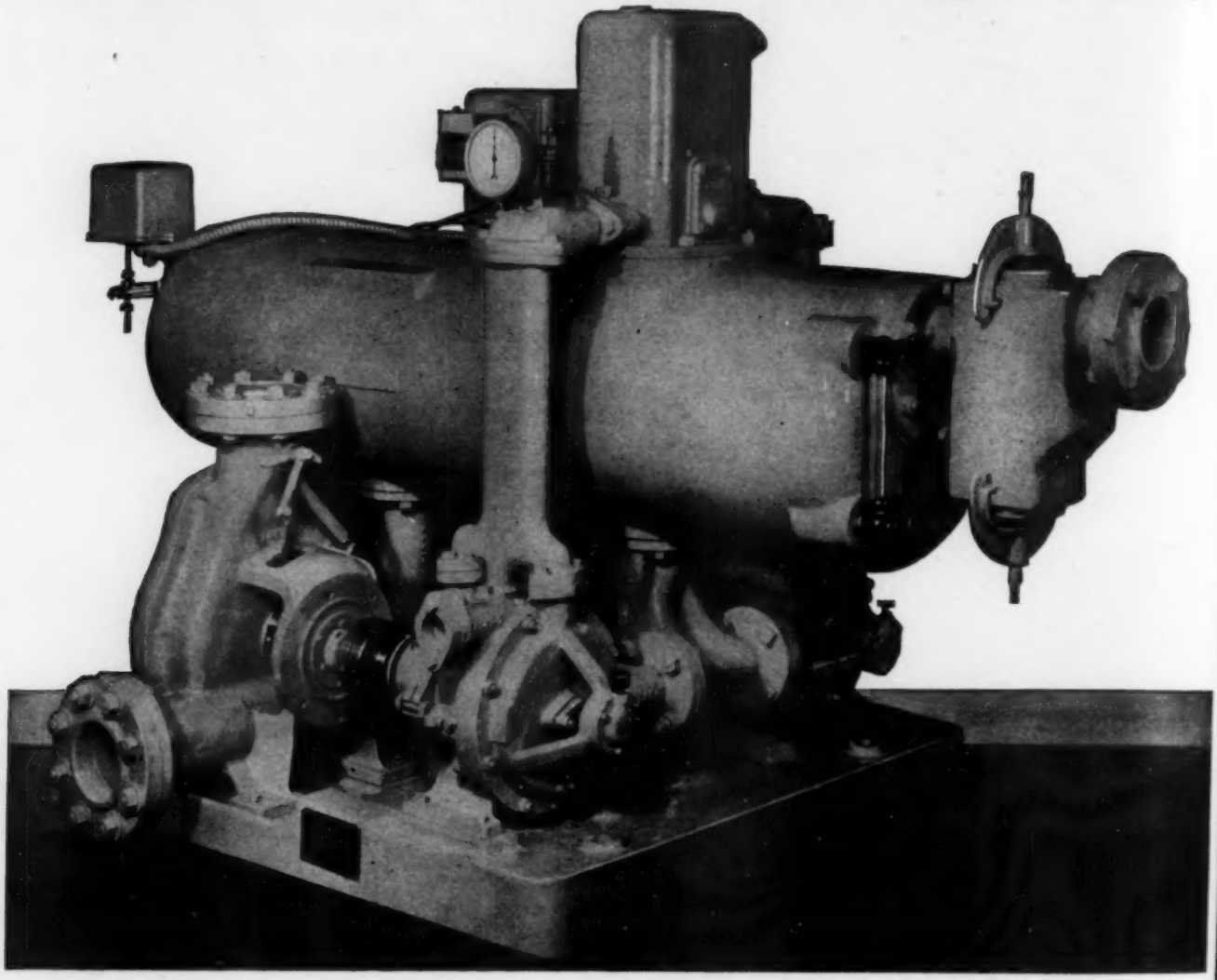
Where Heat Must Not Fail– Install this SAFE Heating Pump!



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Preventive Maintenance Keeps Motors On Job

B. M. Brown, Industrial Application Engineer, and W. W. McCullough Maintenance Engineer, Explain Importance of Taking Care of Motors in Wartime

To KEEP motor driven heating, piping, and air conditioning equipment operating during this period is a problem which warrants serious consideration. An intelligent motor maintenance system aims at more than repair of breakdowns; the ideal system aims at *prevention* of breakdowns. Maintenance involves competent, periodic, and systematic inspection. A thorough survey of each motor installation should be made and a systematic inspection and maintenance schedule established and enforced.

Records must be kept consistently on the schedule selected. Several excellent record systems have been developed and reduced to printed form, so that it is not necessary to go to the trouble and expense of devising individual systems.

Prevention of breakdowns may be helped by a thorough analysis of the equipment involved. For example, if the difficulty is the frequent tripping of overload relays, it may be the installation of a different type of relay with thermal guards on the motor will enable the motor to carry the loads without an injurious temperature rise.

Maintenance Schedules Should Include Systematic Inspection

It is impossible to give any hard and fast rules for frequency of inspection. The following suggestions are based on average conditions found for heating and ventilating systems.

Once a week check oil level in the bearings and see that the oil rings are moving freely. Check the temperature of the motor bearings and primary iron with the hand. Sniff the warm air coming from open motors. The fumes emanating from overheated insulation are unmistakable.

Once a month check the brush holders, brushes, and shunts. Blow out the motor with compressed air.

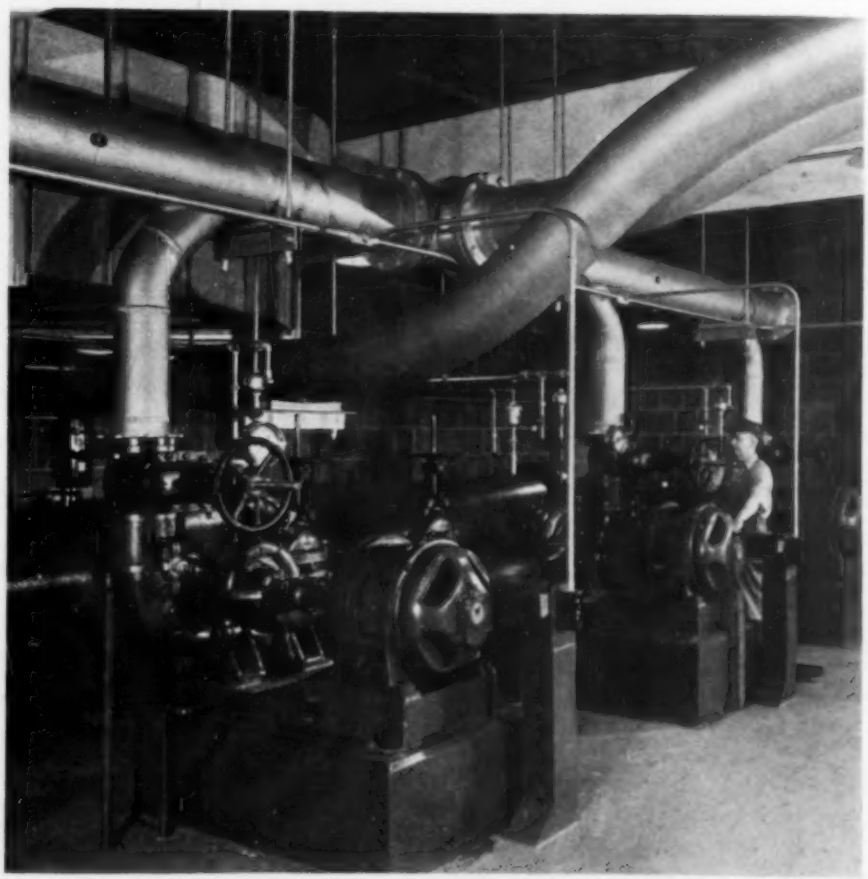
Once a year or at the start of each cooling or heating season, check air gap with feeler gage. Check insulation resistance with megger. Check line voltage with voltmeter, and load with ammeter. Clean out and replace grease in ball and roller bearings. Check renewal parts stock in light of the past years' experience.

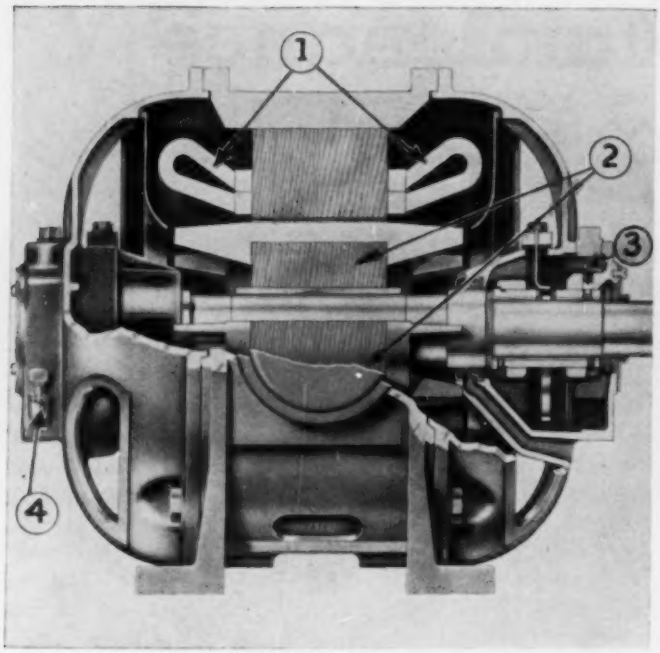
Every two years dismantle the motor. See that all windings are tight. Replace loose wedges and loose bands before dipping in varnish and baking. Inspect commutators and commutator connections. Sleeve bearings require no flushing. At intervals of about two years in average service, or during general overhaul periods, remove the bracket and wash out the bearing housing. Use hot kerosene oil and compressed air if available.

Faulty Bearings Cause Most Motor Failures

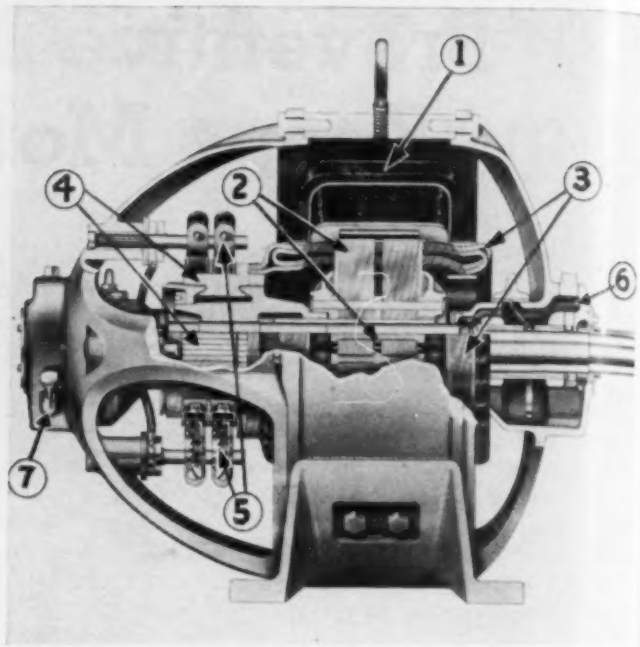
All motors depend upon a mechanical assembly of some sort for the transformation of electrical energy into mechanical energy or work. The bearings are a very im-

An adequate maintenance program is required to keep motors operating at peak efficiency. Routine inspection and cleaning have prevented many costly hours of delay and saved many maintenance dollars





Cutaway view of a-c squirrel cage motor. (1) Stator coils, (2) squirrel cage rotor, (3) sleeve bearings, (4) oil overflow and filler plug



Cutaway view of direct current motor. (1) Field coils, (2) armature, (3) armature coils, (4) commutator, (5) brush rigging, (6) sleeve bearing, (7) oil overflow and filler plug

portant link in this mechanical assembly.

Bearings probably cause more shutdowns, delay, and expense than any other cause. This is not surprising, when it is remembered that they are victims of poor foundations, misalignment, vibration, thrust from couplings, dirt, under and over lubrication, and frequently the wrong lubricant—all this in addition to their real job of supporting a rapidly revolving part.

Lubrication of Sleeve Bearings

The first requirement of successful bearing operation is lubrication. This entails more than just an adequate supply of lubricant; the lubricant, the bearing design, and its condition must be correct.

Sleeve bearings sustain the essential oil film to prevent metal-to-metal contact between the shaft and the bearing surface. Properly designed bearings have adequate area for the load, proper oil grooving, working oil rings, and suitable materials.

Safe operating temperature for bearings under normal operating conditions is considered to be 104 F rise above the surrounding room air. Assuming proper mechanical condition of the bearing, whether sleeve or ball, and the bearing assembly, and assuming that proper lubricants are used, temperatures elevated above 104 F rise call for immediate investigation.

In a sleeve bearing the oil sticks to the shaft and is dragged along by the rotation of the shaft so as to form a wedge-shaped film between the shaft and the bearing. This film of oil carries the load, and prevents metal-to-metal contact. So long as this film is established and maintained there is no metal-to-metal contact in the bearing while the shaft is rotating and, therefore, no perceptible bearing wear.

Two outstanding considerations govern the maintenance of sleeve bearings. The first is to insure the existence of the oil film once rotation has begun. *Use the right oil.* The second is to minimize the destructive effects of metal-to-metal contact when the film is lost, either by accident or during the starting period. *Use the right babbitt.*

For sleeve bearings, proper maintenance keeps oil well filled to the proper level and the oil rings turning freely. New oil should be added only when the motor is at rest to prevent overfilling of the reservoir. Oiling of bearings is more often overdone than underdone. Sleeve bearings which require frequent refilling and thereby leak oil onto the stator windings should be replaced with sealed sleeve-type brackets and bearings.

It is well known that oil rings generally carry far more oil than is necessary for proper lubrication of the bearing. When running, most of this oil is carried on the outside diameter of the rings. This excess oil causes splashing and spray inside of the bearing housing. Air currents that pass through the housing pick this spray up and deposit it on motor windings. Sealing the bearing against the entry of air currents is therefore necessary and is accomplished by close tolerances, felt seals, and air bypasses to offset blower action of rotating parts.

The purpose of the felt washer in these seals is often misunderstood; the real purpose is to keep out air and dirt. In itself it has little value for preventing leakage

"A Stitch in Time

Saves Nine," the saying goes. It's true particularly with mechanical and electrical equipment, where a few minutes—regularly scheduled—can prevent trouble which later on may take hours to repair. . . . With motors operating under peak loads and the demands of the war effort limiting their replacement, the importance of an adequate preventive maintenance program cannot be overstressed. In this article the authors—both of Westinghouse Electric & Mfg. Co.—tell how the proper maintenance can help make motors last for the duration.

of oil once it becomes oil soaked. Bearing wear, which means radial movement of the shaft, spoils the effectiveness of the bearing seals. Replace all felt seals at the same time when replacing sleeve bearings. These felt seals should be ordered from the manufacturer of the motor. If it is necessary to make them in an emergency, use high grade felt not less than ¼ in. thick before compression. Make the inside diameter of the washer the same as the shaft or slightly less. Cut the felt true with edges at right angles to the surface of the felt.

Oil leakage is generally aggravated by high temperatures. Keep bearings cool and use an oil that does not foam easily.

Clicking Sound May Indicate Ball Bearing Trouble

Ball bearings have become increasingly important with the use of totally enclosed and fan cooled motors. In a sleeve bearing, as just explained, the shaft when in motion is separated from the bearing by the oil film. In a ball bearing, a series of steel balls acts as the separating medium, both when the motor is stationary and when it is running.

To keep the steel balls uniformly distributed around the bearing a cage or retainer is used, each ball having its own pocket. The balls have rolling contact with the raceway, but sliding contact with the surfaces of the retainer. This means that lubrication is necessary.

Most ball bearings used in horizontal motors are grease lubricated, although some supplied with vertical motors use oil. Follow the advice of the motor manufacturer in selecting a suitable grease. Carelessness in allowing containers to remain open often causes trouble from abrasive dirt. Soda base soap greases are usually preferred on account of their high melting point and their stability. They mix readily with water, however, and tend to form an emulsion.

Ball bearings in distress can usually be detected by undue heating or by unusual noise. Broken or nicked balls cause rapid destruction of the bearing. This can be detected by the "clicks."

If the conventional 104 F rise above the surrounding air is exceeded, look for an overfilled bearing, since the first result of overgreasing is heating caused by churning of the grease. The general rule is that the housing should not be over half full. Clean the old grease from the bearing and from the housing once a year and replace it with new grease. Average service is assumed.

After the machine is dismantled, the bearing should be carefully wrapped in clean cloth or paper to protect it from outside dirt. Remove all old grease from the housing and clean the housing and the bearing either in the proper

Periodic cleaning prevents dust and dirt from getting into the motor windings

solvent or in carbon tetrachloride. This is a difficult operation because particles of grit are not soluble and are removed with difficulty. Remove the final residue of the cleaning medium with a light oil before filling with new grease. The container with fresh grease must be carefully protected from dirt. Keep the cover on tight. Use a clean, nonmetallic paddle for applying the fresh grease.

Check Air Gap with Four Readings

The air gap in a motor is dependent, first, upon proper maintenance of the bearings and, second, on the proper alignment of the brackets or pedestals with the frame. Alternating current motors operate with less gap than direct current motors, and are therefore more critical. Check the air gap with a feeler gage at the established schedule period. Make these checks at the pulley end, taking four readings on each motor, 90 deg apart. For motors below 10 hp, a minimum gap of 0.005 in. should be maintained. Above 10 hp, the minimum gap should be 0.010 in.

Couplings Require Alignment

Where coupled type motors are used, the couplings require regular inspection. Faulty alignment in a solid coupling is reflected in bearing trouble and vibration. Make sure that all dowel pins are in correct position and check the faces of the couplings with a feeler gage after the bolts have been removed. Shift the motor position to make the faces of the two half couplings parallel.

Flexible couplings will operate under more severe misalignment without causing trouble; however, the two halves should be checked with a steel scale to make sure they are in alignment. Any misalignment means increased wear on the pins, fingers, and leather discs, whichever may be used. Special type flexible couplings should be checked according to the manufacturer's instructions.

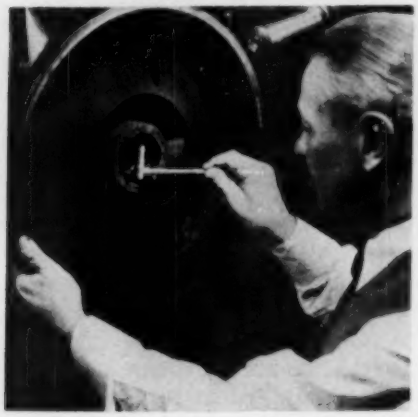
Insulation Must Be Clean and Dry

The electrical conductors in a motor are separated from the magnetic circuit and from the mechanical assembly by materials generally grouped under the term "insulation." Insulation is also used in commutators to separate the bars from each other and in coils to isolate individual turns. It is important that the insulation be maintained so as to function as a separator between the copper coils in the motor and the mechanical assembly. Regardless of the class of insulation used, remember that electrical insulation materials are nonconductors only when clean and dry.

The importance of keeping electrical equipment clean and dry is always worth stressing. Accumulations of dust and dirt not only contribute to insulation breakdown, but they operate to increase the motor temperature through restrictions of ventilation. Dust and dirt are effectively removed with compressed air at about 50 psi pressure. Do not direct compressed air against the insulation until certain that it is free from moisture that may have accumulated in the air line from condensation. Too great an air pressure may loosen the binding tape or injure the insulation by sandblasting with the abrasive dirt which is nearly always

present. It may not be possible to remove all dust and dirt by blowing with compressed air. If the accumulation of dirt contains oil or grease, a solvent will usually be required to remove it.

There are three types of solvents in general use for this purpose.



Eleven years of severe and continuous service showed a bearing wear of less than 15/10,000 in., thanks to proper lubrication and intelligent maintenance

These are petroleum distillates, such as Stoddard solvent cleaners' naphtha, carbon tetrachloride, and a mixture of the two. The petroleum distillates are the solvents having the least corrosive action on insulation varnishes, and for that reason where conditions permit are preferable to the others. The Stoddard type solvent, produced by all the major oil companies, with a minimum flash point of 100 F, minimizes the fire hazard, and should be used in preference to gasoline or benzene. Every precaution should be taken, however, to prevent fires or explosions.

When this type of solvent will not properly clean the apparatus, a mixture of carbon tetrachloride and the solvent may be used. A mixture of 50 per cent carbon tetrachloride and 50 per cent Stoddard solvent is nonflammable, but the vapors mixed with a right proportion of air are explosive. In extreme cases it may be necessary to use straight carbon tetrachloride; however, the toxic effect of this material on the operator must be taken into consideration.

Carbon tetrachloride is more corrosive in its action than petroleum solvents, and it evaporates much more rapidly. For this reason the residue of carbon tetrachloride should be removed by applying a petroleum solvent. This will prevent corrosion later on.

Before any solvent is used, be sure that there is good ventilation and minimum fire risk. Do not let clothing become saturated with the solvent. Always have fire extinguishers of the carbon tetrachloride type handy. If a hose is used to spray either cleaning solution or varnish, make sure that the nozzle is grounded. Workmen should be guarded against breathing the fumes of carbon tetrachloride and they should be under the close observation of someone familiar with artificial respiration. Where conditions are particularly bad, such as in pits, gas masks should be worn.

The time to apply varnish treatment is after the motor has been thoroughly cleaned in solvent. Use a baking varnish recommended by the supplier for the particular conditions encountered. Two dips and bakes may be sufficient for normal conditions, while for extreme conditions of moisture and corrosive gases four dips and bakes may be justified. One or two additional coats of red synthetic enamel may be justified under extreme conditions.

Dry the motor in an oven before dipping in varnish. Electric or steam heat is safe and convenient. Make sure that suitable temperature control is provided and that it is effective so as to prevent injury to the insulation. Maximum dryout temperature is 240 F. Baking temperature for the varnish and length of the baking period will depend upon the type of varnish used.

Insulation Testing Determines Comparative Conditions

Insulation tests are made to determine the condition of the insulation rather than the quality of the insulation. While special conditions may justify dielectric tests, over potential tests, high frequency tests, or dielectric power factor tests, a test to determine the insulation resistance is generally all that is required in maintenance work. Use class B insulation for motors whose history shows breakdowns resulting from operation at elevated temperatures.

The most convenient way to read insulation resistance is with a megger. The 500 volt type is generally used. A higher voltage megger may damage low voltage insulation. Remember that the readings are valuable only from a comparative standpoint and that they vary greatly with the temperature of the apparatus. A safe general rule is that the insulation resistance should be approximately one meg-

Oiling the motor regularly is essential to a long bearing and shaft life. Too much oil may contaminate the motor windings, causing possible deterioration of the insulation

ohm for each 1000 volts of operating voltage, with one megohm as a minimum.

Totally Enclosed Motors Protected from Outside Air

Totally enclosed motors and totally enclosed fan cooled motors have the frames sealed so as to exclude the outside air. They are well protected against the admission of abrasive dirt and metallic particles that shorten the life of insulation in open motors. For these enclosed motors there are two points to observe.

First, see that all exposed joints in the motor frame and brackets are tight. Use a water resistant grease in the bracket fits if the motor is dismantled for any reason. This will help to prevent accumulation of water in the bottom of the motor frame.

Second, make sure that the motor is provided with a drain plug or drain pipe at the bottom of the frame so that any accumulated water can be removed before causing trouble.

Careful Handling Required for Direct Current Motor Repair

Direct current motors add the commutator and its current collecting details to the general maintenance problem. The armature is

the heart of the direct current motor. Through it flows the main line current, and if the machine is overloaded the armature is the first to give evidence of distress.

When dismantling a d-c motor for periodic overhauling, the following points should be observed:

To assure proper maintenance and prevent sparking, it is necessary to undercut the mica below the surface of the faster wearing copper commutator bars on a direct current motor. This tool undercuts the mica to 1/16 in. below the commutator surface

Do not roll the armature on the floor; a coil may be injured or the steel banding wire may be nicked. Support or lift the armature only by its shaft if possible. Never allow the weight of the armature to rest on the commutator or on the coils. Inspect the coils carefully to see that they are tight and where necessary replace the wedges. Replace any bands that may be loose.

As far as possible duplicate the banding originally furnished by the manufacturer. Do not change the material in the banding wire, the diameter of the banding wire, or the width or position of the band. Increasing the band width may cause heavy currents in the bands sufficient to overheat and melt the solder.

Only experienced workmen should tighten loose commutators. If the commutator bars are tight they will give out a clear, bell-like ring when tapped lightly with a small hammer. If the commutator does not ring, but gives out a flat sound when struck, the front V should be tightened.

The exposed portion of the front mica V ring is normally a catchall for oil and dirt. This section should be cleaned and protected with a layer of surgical tape and twine to prevent flashovers and breakdown to ground. Red synthetic enamel will give a smooth finish, resistant to oil and carbon dust.

Uniform Spring Tension on Brushes Prevents Selective Action

Check the brush rigging carefully. Most brush holders in use today are box type, and the brush holder should be replaced when the inside broached section is worn.

The brushes themselves must fit properly, not so tightly as to stick and not so loosely as to shift position when running. Make sure that the grade used is correct for the application, using the advice of the manufacturer of the motor. Make sure that the fit of the brush on the commutator extends across the face of the brush.

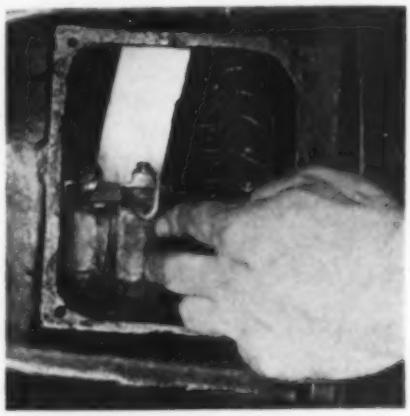
The spring tension on the brushes should be uniform so as to prevent selective action. The correct pressure will vary with the design of the machine, and adjustments should follow the recommendation of the manufacturer. The brushes should be staggered in pairs of arms to prevent grooving of the commutator. Brush shunts should be kept tight and free from excessive corrosion so that current will be uniformly distributed to the brushes. Under bad conditions of corrosive atmosphere the shunts can be protected by dipping in melted paraffin or in synthetic red enamel or by covering with woven cotton tubing.

Resurfacing of the commutator should be done in a lathe or with a grinding rig. As it is impossible to obtain a true surface with a hand stone, it should be used only as an emergency. Practically all d-c machines have undercut mica in the commutators. This undercutting should be kept 1/16 in. deep.

Lubricating Oils for Gear Motors Vary with Speed and Load

A gear motor is a self-contained drive made up of a ball bearing motor and a speed reducing gear unit. It is designed to take advantage of the electrical efficiency of the high speed motor and the transmission efficiency of accurately cut and properly designed gears.

Suggestions already given apply to the motor element of the gear motor unit. Front and motor bearings are generally grease lubricated and require the same attention as in standard ball bearing motors. Rear bearings, gear box bearings, and the gears themselves are almost always splash lubricated from the same oil supply reservoir in the lower section of the gear unit. Oil seals at each bearing prevent oil leakage into the motor windings



A thorough maintenance program does not neglect brushes. Proper method of cleaning and surfacing is to press brush down in a strip of sandpaper placed between brush and commutator. Several passes should be sufficient, depending upon brush condition. The sandpaper should be held flat against the commutator surface to prevent rounding of the brush end

and out along the driving shaft. The precision cut gears demand carefully selected lubricating oils. Use only top grade oils of the viscosity called for by the manufacturer of the gear motor. Give full particulars as to type of units and operating conditions.

The areas of contact on gear teeth are relatively small and the pressures produced in transmitting the loads are relatively large. It is essential to provide a film of lubricant of sufficient strength to withstand the localized pressure during the period of contact. The peripheral speed of the gear governs the period of tooth contact and determines the time during which the film must withstand the pressures. When speeds are high, the time is very short, the loads are usually light, and a comparatively light bodied lubricating oil can be used. When speeds are low and the loads heavy, the contact time is considerably longer and a heavier bodied oil should be used.

See that the oil level marked for each gear motor unit is maintained. For normal operating conditions, drain the oil reservoir in the lower section of the gear case once a year and refill with new oil.

Air Conditioning Makes 24 Hour a Day War Production Possible

C. G. Lauckner, III, Tells How Air Conditioned Blackout Plant for Airplane Supercharger Manufacture Performs

THE AIR conditioning system for a new windowless factory "somewhere in New England" being used by General Electric for the manufacture of turbosuperchargers was designed and laid out on the basis of 50 per cent of the production which is actually being turned out at the present time. It was calculated that the steam for heating would be 12,000 lb per hr, at the most, assuming that no machines were running and no persons were in the building. Production has doubled since the system was installed, making necessary many changes in manufacturing layout as well as the addition of a large number of machine tools.

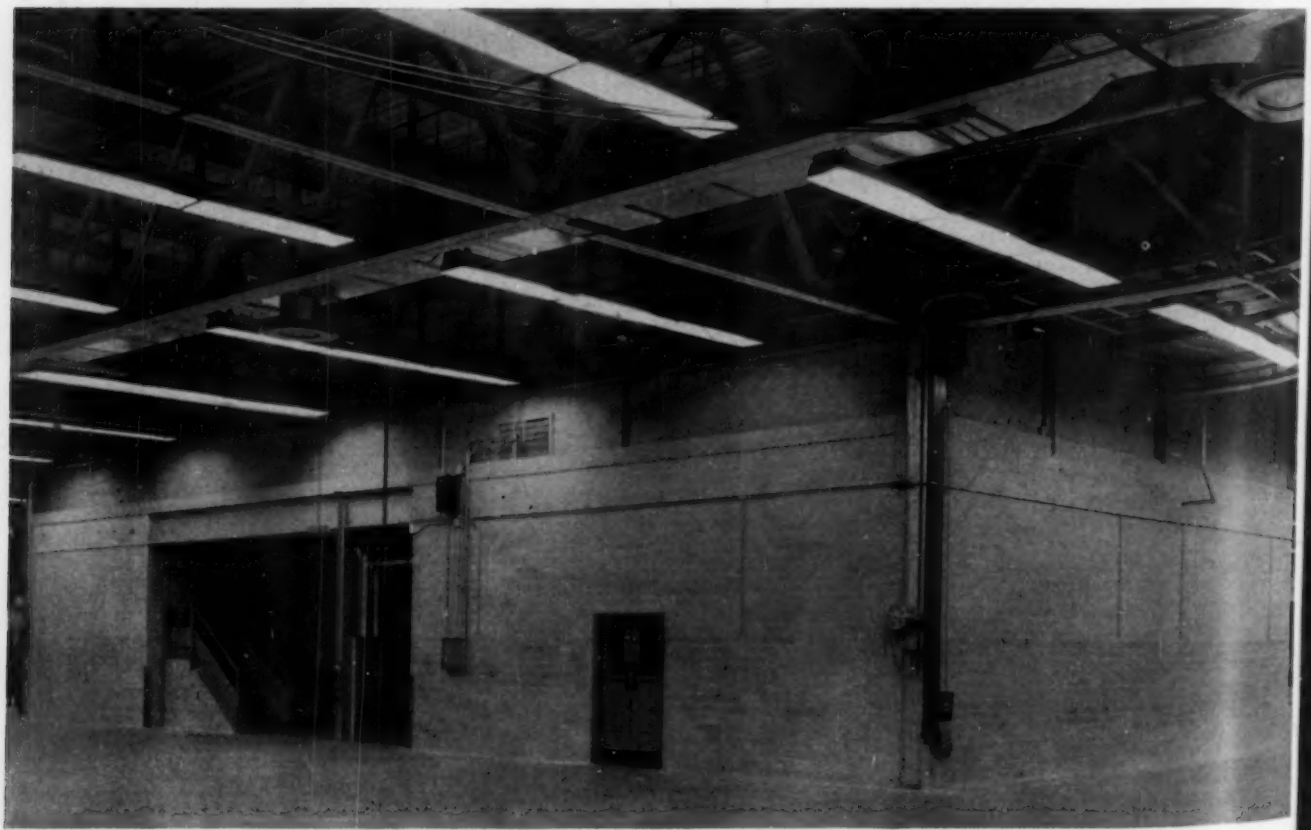
The operation of the plant during the cooling season of 1942 proved that the air conditioning system could maintain desirable working temperatures in spite of the above unforeseen conditions. In fact, the results have been most gratifying. The system is operating to maintain a uniform temperature of plus or minus 2 F—adequate in maintaining the necessary tolerances in supercharger production. At outdoor temperatures as low as —18 F, the temperature within the building has been maintained at 75 F without difficulty. The heating steam demand has not exceeded 3000 lb per hr even on the coldest day. At temperatures as high as 95 F, an indoor temperature of 80 F, or a temperature differential of 15 F, has been maintained.

The building's well insulated roof, plus the tile and brick outside windowless walls, make the building exceptionally easy to heat. The major part of all the air is recirculated when the outside temperature is below 50 F.

Boiler room attendants operate the air conditioning system. Twice during each shift, a boiler room attendant makes a complete circuit of the air conditioning equipment, checking the position of valves, condition of bearings, and also the temperatures in each zone of the plant.

Three oil fired, integral-furnace-type boilers, each capable of producing 60,000 lb per hr of steam at 200 lb psi, have been installed in the boiler house. A portion of the

One of the mezzanines which house major air conditioning equipment. Centrally situated with respect to load, the mezzanines are built into the building structure so that all machinery, ductwork, and outlets are above the 18 ft level. Handling two of the six independently controlled zones in the plant, each mezzanine has two machine rooms containing compressors, fans, coils, and controls for their zones. This particular mezzanine also houses the plant dispensary. On each side of the mezzanine above the 18 ft level are vents where return air from the plant comes back to the system



output of one boiler is used for heating and to operate the turbine driven cooling water circulating pumps, and the balance plus the output of the other two boilers is used to furnish steam for the testing chambers. In the same structure are several electric furnaces for heat treating metal parts. Near the boilers are two 1000 cfm air compressors which supply compressed air at 100 psi for the production machines. These compressors are driven by two 250 hp motors.

All induced draft fans are driven by mechanical drive turbines and the exhaust steam is used for feedwater heating. An induced draft fan is built into each stack; the latter are short to facilitate camouflaging. Boiler feed pumps are driven by turbines and electric motors.

Boiler makeup is approximately 90 per cent, since large amounts of steam are consumed in the test system. To offset excessive use of water in the plant, the cooling water for the two 1000 cfm air compressors and aftercoolers is used for the boilers and is carried in a closed system to the normal inlet valve of the deaerating heater. During the summer months, surplus water from this source is dumped into the outgoing line to the cooling tower and serves as a source of makeup. During the winter months the excess water is deposited in the sewer.

Briefly described, the turbosupercharger manufactured at this plant is a miniature turbine which operates directly off the exhaust gas of an airplane engine to turn a compressor forcing into the engine's cylinders compressed air needed for operation in the thin air of high altitudes. Airplanes are thus able to attain great speeds and maximum efficiency high up over weather levels.

The plant—whose heating and air conditioning equipment was briefly described during construction in the September, 1941, HPAC—is an attractive one story brick structure providing several acres of production floor space. It consists of a main manufacturing section, with an attached boiler house, test, and forge shop. Off the production floor are the production offices, restrooms, drafting room, and dispensary—all completely enclosed. At the entrance, a few hundred feet from the main structure, is the administration building—of brick construction—which also houses the personnel and plant protection offices.

Commenting on the new building, J. G. Trudinger, G. E. plant engineer in charge of the design and construction, points out that "continued progressive advances in the sciences of air conditioning and lighting have made possible the creation of desirable controlled working conditions in this type of windowless plant. It is now possible to maintain 24 hr operation of a factory under conditions favorable to all of the working shifts, a highly important factor in these days when every industrial organization is striving toward maximum output.

"It is interesting to note that progress has not been confined to air conditioning and lighting. New ventilating, insulation, and acoustical control devices are all making their contributions. We must not overlook the fact, too, that in addition to the complete elimination of dirt, dust, and draft in 'windowless' buildings, substantial savings may be effected in window maintenance."

Pressure cleaning rooms, etch test, grinders, and chemical laboratory are equipped with exhaust systems. The rest rooms and dispensary have their own ventilating systems, while the cafeteria is tied into the main air conditioning system.

The major portion of the internal sensible heat load in the factory consists of heating equipment and power machinery used in the manufacture of the turbosupercharger. Since the building is well insulated, the amount of heat released by this equipment when the plant is operating at full capacity is sufficient to heat the building until the outdoor temperature drops below 15 F. Consequently, the air distribution system was sized and located to balance the internal load on cooling, with only small modifications at points of maximum heat release to allow for some lack of balance between heating and cooling loads.

The manufacture of turbosuperchargers involves numerous very accurate machining processes on metals which require very close control of temperature throughout the year for successful results. This was the primary factor in the design of the air conditioning system. As far as possible, however, every effort was made to maintain, at the same time, air conditions within the comfort zone.

The air conditioning system requires hundreds of tons of refrigeration, which is provided by more than fifteen 60 hp, eight cylinder reciprocating condensing units and direct expansion coils. There are six fans which serve six independently controlled zones in the plant. All major equipment is in three mezzanines centrally placed with respect to load and built into the building structure, so that all machinery, ductwork, and outlets are above the 18 ft level. Each mezzanine has two machine rooms containing the compressors, fans, and coils for the zone served from this space.

Outside air is introduced at each mezzanine through the roof directly above at the rate of 100,000 cfm, sufficient to produce four changes per hour in the conditioned space, except during cooling or heating load peaks. At such times it is reduced to one change per hour. As the building has no windows and only a very few openings, full exhaust capacity for the entire amount of outside air introduced is provided by 18 exhaust fans placed under the eaves of the building. All air in the building is cleaned by

Production Tool

In the words of the engineer in charge of the design and construction of this windowless factory "somewhere in New England" for the manufacture of turbosuperchargers, "advances in the sciences of air conditioning and lighting have made possible the creation of desirable controlled working conditions in this type of plant. It is now possible to maintain 24 hr operation of a factory under conditions favorable to all of the working shifts, a highly important factor in these days when every industrial organization is striving toward maximum output."

Mr. Lauckner, of the maintenance & engineering department of General Electric Co., reports briefly on the performance of the plant's air conditioning and heating systems, and adds further details to the preliminary description of the installation published in the September, 1941, HPAC.

automatic air filters operating continuously.

Air is distributed to the six zones through ductwork of standard construction and ceiling discharges of the venturi bowl type, located at the bottom of the building trusses, about 18 ft from the floor.

Heating is accomplished with steam coils modulated in six steps for each zone and requires a maximum outlet temperature of only 25 F above room temperature under design heating conditions. The air outlets are in the center of each 40 ft bay with a downward angle discharge sufficient to provide a thorough mixing of the discharge air at the floor level both under heating conditions and under cooling conditions with a discharge temperature 20 F below room temperature.

A large cooling tower of more than 1000 tons capacity is situated a short distance away from the building. All piping is cast iron outside of the building and welded steel inside. Piping is distributed to the condensers through tunnels under the floor of the manufacturing space, with risers running up to the three mezzanines along the columns of the building.

Welding of a high pressure steam line in turbosupercharger building

FACTORY EMPLOYEES LIKE RADIANT HEAT

When the Murray Corp. decided to build an addition to its plant at Towson, Md., the main objective was to construct a modern factory with the use of a minimum amount of metals and other critical materials. A radiant heating system was installed in the addition.

Finished coils for the installation were laid on strips of 1 in. insulation board resting on a 6 in. crushed stone fill. The coils were then covered with a 6 in. topping of concrete. The concrete slab is the factory floor

An inspection made on one of the coldest days last winter, when the outside temperature was 10 F and a strong wind was blowing, showed the temperature in the addition, with radiant heating, to be 65½ F, and that it was "definitely comfortable" and there were "nc drafts."

The president of Murray Corp. half-jokingly reported that employees were competing with one another to be transferred to the new addition. He added that management and personnel alike were "sold" on radiant heating.

The radiant heating system consists of 2360 ft of 1¼ in. wrought iron pipe assembled into three "banks" of grid coils. Strips of 1 in. insulation board, 8 in. wide, were laid on the 6 in. crushed stone fill under each run of pipe. A 6 in. topping of concrete was then poured.

Several factors influenced Murray Corp. officials in deciding upon radiant heating for the plant addition. They wanted a concrete floor but were fearful of employee discomfort. Radiant heating suggested itself as a natural answer to this problem. Also, they wanted to utilize every inch of floor space.

Radiant heating is considered by many to be one of the major promises of the building industry for postwar housing as well as for commercial and industrial building.

SAM LEWIS' PAGE

By Samuel R. Lewis
Consulting Mechanical Engineer

Member of HPAC's Board
of Consulting & Contributing Editors

A CORRESPONDENT who represents a district steam heating company presents an unusual problem. One large customer has four separate vacuum pumps in different locations below the respective heating systems. The pumps are designed to remove condensate and air and then are to force the condensate, after separating out the air, into an overhead tank. Atmospheric pressure is in this tank and the water flows out through a condensate meter on its way to a return main.

Complaint is made that the pumps all tend to discharge condensate through the air separators when starting to run, after an off cycle. To conserve this condensate and to be sure that compensation for it is received, the district steam heating company has installed a separate meter on the air discharge pipe from each vacuum pump.

These meters have demonstrated that the conservation of the water from the discharge pipe is worthwhile, but it is now desired, if practicable, to remove the four condensate meters from the air discharge pipes for use elsewhere, and to save the labor of reading these four extra meters every month.

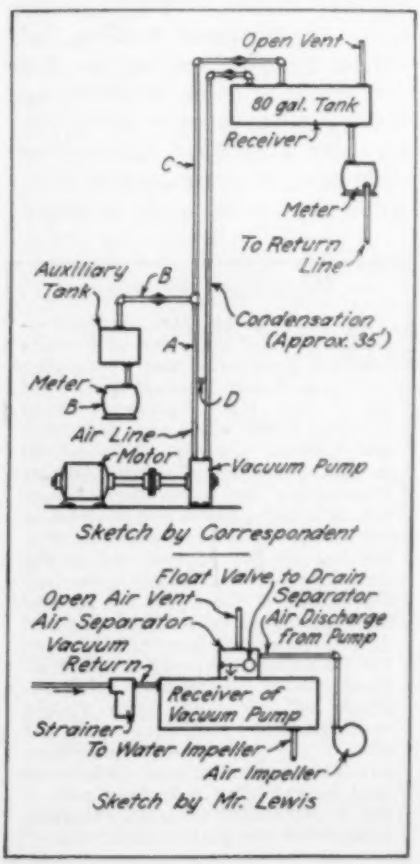
A sketch accompanies the letter, illustrating diagrammatically the piping connections for one of the pumps. The air discharge pipe *A*, usually open to the air close to the pump and usually entirely free of condensate, has been extended as indicated by *A-B* with an extra receiver and meter *B*. The *A-B* meter combination is said to operate satisfactorily.

It is proposed, in order to release the extra tanks and meters, to remove the pipe *B* and to extend the vacuum pump air discharge pipe as shown by *C* so as to discharge the air and condensate into the overhead receiver, the pipe *A-C* being about 35 ft high.

It is proposed as an alternative solution, so as to release the pipe *B* and the tank and meter, to connect the air discharge pipe *A* directly into the pump discharge pipe *D*, removing the riser *A* and the pipes *B* above this point.

In comment on this project, I offer the following:

The vacuum pumps each have separate water and air impellers. The water pumps must work against a head of 35 ft or about 15 psi; neglecting friction, plus the suction pressure, which may vary widely, depending upon what vacuum is maintained. The air impellers are not designed to operate against any serious head of water, as seems to be maintained in pipe *A* up as far as pipe *B* leading to the auxiliary tank. It is not clear from the drawing, though perhaps it is understood, that the auxiliary tank has an open vent.



The vacuum pumps originally were designed for 10 psi discharge pressure. They were changed later to 50 psi discharge pressure, perhaps by installing new water impellers and by increasing greatly the speed of rotation. It is possible that when this change was made some improper change also was made in the air discharge mechanism from the pump. Ordinarily the air impeller discharges a mixture of air and water into a separator above the suction receiver of the pump. I have made a sketch illustrating the usual principle of operation.

This separator has a free vent to the atmosphere and a drain connection into the pump receiver, this drain valve being opened by a float only in case there has accumulated enough water to lift the float. The water flows quickly into the pump receiver if the latter is at subatmospheric pressure.

It is conceivable that the heating system return pressure is such—due to leaking traps, high steam pressure, or weakness of the water impeller against its heavy discharge head—that water in the separator will not fall into the pump receiver but will be forced up into the separator vent when the separator float lifts the drain valve. This could happen if the pressure in the pump receiver is not subatmospheric.

The proposed connection *C* definitely is condemned, since it will cause a still greater head against which the air impeller must operate, and the proposed connection *D* is still worse, since then the discharged air will have to enter a pipe which assuredly is full of water under a very substantial pressure.

The auxiliary tanks and meters should be removed. The solution to this problem lies along the line of correcting the vacuum pump operation. Too many of these pumps are running, year in and year out, with the air vent pipe entirely free of water, to justify the presence of the auxiliary tanks and meters.

If the air eliminator float and valve are free to operate as designed by the pump manufacturer, there should be no waste of condensate through the vent pipe.

Comfortization of Airplanes

Albert A. Arnhym Discusses the Heating and Air Conditioning Engineer's Part in the Art of Minimizing Discomforts Inherent to Flying

THE MOST powerful automobile is a useless piece of machinery if such minor parts as its spark plugs are removed. By the same token, an airplane depends upon all of its accessories to function properly, and if any one of these accessories is missing or working unsatisfactorily, the operation of the entire plane will be adversely affected or even become impossible.

The most vital accessory of an airplane is its crew. Although this should be self-understood, less consideration has been given to their efficient functioning than to less important accessories. It has become the task of the newly created art of aircraft comfortization to minimize or eliminate the numerous discomforts inherent to flying at great altitudes, low air densities and temperatures, as well as the tremendous speeds, rapid changes of altitude, and other factors which are part of military maneuvering in the air.

Requirements for Aircraft Heating and Ventilating Equipment

Foremost among the many phases of comfortization are air and heat supply, although the equipment required for these purposes has created innumerable problems which are quite different from those pertaining to air conditioning on the ground. Summarizing the requirements which such equipment must meet on military aircraft, as discussed in greater detail in the February HPAC article, the following factors must be considered:

1) *Low burden.* The comfortization equipment should add the lowest possible burden to the airplane by (a) keeping weights to the absolute minimum; (b) requiring very little room and being shaped in such a manner as to fit into available spaces; (c) not interfering with any of the other components of the airplane; (d) consuming very little electric current, fuel, etc.; (e) high efficiency.

2) *Safety.* The operation of the comfortization equipment must be absolutely safe. Therefore, it must (a) not add new hazards such as the danger of explosions, fire, poisoning by carbon monoxide, and other toxic gases or fluids; (b) be fully foolproof so that mistakes in handling or unforeseen contingencies will, under no circumstances, result in failures or injury to the plane, its accessories, and crew; (c) be reasonably protected against damage by enemy fire and its consequences.

3) *Simplicity.* Flight and ground crews are so occupied with other tasks that the comfortization equipment should not demand unreasonable attention and service. This can be attained by: (a) making all controls as simple as possible and, whenever feasible, fully automatic; (b) keeping the need for servicing to a minimum and making all such parts as require servicing from time to time, easily accessible and replaceable; (c) avoiding use of such materials, service tools and replacement parts, the supply of which is difficult in times of war.

4) *Airworthiness.* The comfortization equipment and all of its components must be fully airworthy. This prescribes design based on (a) very low air densities which may be only one-third or even less of those on the ground; (b) extremely low temperatures, which may be less than minus 100 F; (c) low humidity which, at great altitudes, approximates zero; (d) tremendous gravitational forces caused by steep banks at high speeds and other rapid changes of the altitude of the plane.

While many of the factors listed under 1, 2 and 3 apply, to a certain degree, also to air conditioning equipment on the ground, they represent only desirable features which may be considered as long as they do not raise the cost of manufacture unreasonably. For military aircraft, however, these factors are so vital that everyone of them must be fully satisfied.

Air Supply

On commercial aircraft, heating and ventilating installations are normally closely interwoven since the air serves not only for ventilating purposes but also as a transfer medium for the heat supply. On military planes it is necessary to separate them because both air and heat supply have to fulfill so different functions on most of these planes that combining them is usually not feasible.

The requirements as outlined above can be met without too much difficulty in designing the means for air supply to flight crews. It must be borne in mind, however, that the air quantities necessary for physical existence increase with increase in altitude, since the density of the air becomes lower. For

War and Postwar

An article by Mr. Arnhym — formerly chief engineer of Pacific-Airmax Corp., and now consulting engineer, Solar Aircraft Co.—published in the February, 1943 HPAC, dealt with the definition and general aspects of "comfortization"—the art of minimizing or eliminating the discomforts inherent to flying—and a comparison of requirements for heating and ventilating on the ground and in the air. The present article goes into the details of the needs for air and heat supply in military planes and describes the problems arising from the limitations imposed by high altitude flight. It gives a brief analysis of air and heat supply systems, and concludes with the plea to the ground air conditioning engineer to study these systems so that he can play a leading role in the development of comfortization equipment for postwar aircraft.

this reason, it is preferable to work with air weights rather than air quantities inasmuch as the air weight required for breathing remains constant at all altitudes. On the basis of an average air requirement of 30 cfm of air per person at sea level, the air weight per person amounts to 135 lb per hr.

This air weight can be supplied in a number of ways which depend entirely upon the type of aircraft, its service ceiling, number of occupants, requirements of the heating installation, such as the need for ground heating, and other considerations of a military nature. The presently used methods for air supply on military aircraft are the following: (1) natural ventilation; (2) air scoops; (3) oxygen equipment; (4) blowers; (5) superchargers.

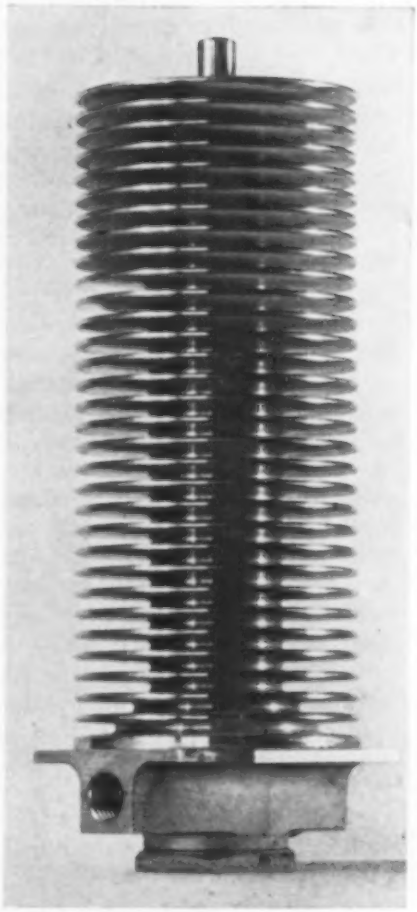
Natural ventilation is usually sufficient at low ceilings. On aircraft of the open cockpit type the fresh air circulation may even be so great that it must be checked in order to eliminate harmful drafts. This applies equally to some low flying planes of the cabin type, such as medium bombers and transports. In these planes infiltration and exfiltration are so strong that they provide the essential air flow without the addition of special equipment. Elimination of drafts is mainly a task of the airplane designer, and not always handled satisfactorily.

Air scoops serve to provide such air quantities as are needed to compensate for insufficient infiltration of fresh air. While foul air spills are often used in conjunction with scoops on commercial air liners, and in such a manner as to cause a slightly positive pressure in the cabin, military airplanes must rely on exfiltration alone in order to avoid drag-producing protrusions on the fuselage. Air scoops can be either rigid or adjustable, and may consist of holes in the leading edge of the wing or deflectors in a positive area of the fuselage. In all cases the design of the scoop must be such as to add a minimum of drag to the plane. Wing scoops are used on many larger planes for supplying air to the heating system, and for ventilation needs on such planes whose cabins are too well insulated for sufficient air infiltration. Similar scoops are used on smaller planes for emergency air supply as, for instance, on dive bombers on which the scoop furnishes a blast of cold air to the pilot to assist him in overcoming the effects of the "pull out".

Usually adjustable, deflector scoops are provided for planes flying at low and medium altitudes to provide any desired amount of air in addition to that taken in by infiltration. This may be necessary for cooling purposes or for passengers who have to be carried in emergencies, as, for example, in evacuating refugees or wounded.

If the service ceiling of a plane exceeds 15,000 ft, neither natural infiltration nor scoops suffice to provide the essential air weight. Unless the cabin is supercharged, oxygen equipment must be used. This equipment may be of either the individual or central type. The individual oxygen supply consists of a mask and a small portable tank, with valves and means for regulation, which is carried by each crew member. The central system consists of a central oxygen supply and feeder lines into which the crew members plug in, with outlets provided at numerous stations. Both systems have advantages and disadvantages. The individual system makes its wearer independent in his movements while, by the same token, it impedes these movements due to its bulk and weight. In addition, the high pressure within the oxygen bottle may cause it to explode, if it is hit by a bullet. The central system eliminates the need for carrying heavy equipment. However, it compells the user to remain within the reach of his supply hose to the oxygen line, and to plug out and plug in if he has to move beyond this reach. The time lost in doing so may have serious consequences. Furthermore, damage to the central oxygen supply system would affect the entire crew and may put the plane out of action.

In spite of these disadvantages oxygen equipment as a means for air supply at great altitudes is the simplest and most efficient method known today, particularly for use on military aircraft. It is up to the comfortization engineer to design and select this equipment in such a manner as to minimize the disadvantages mentioned before and to provide for all contingencies and emergencies.



An exhaust boiler for an airplane steam heating system, which was turned from a solid piece of stainless steel

The use of blowers is confined to installations in which forced draft is unavoidable. The weight and bulk of the blower, the necessary ducting system, and the motor with its current requirements, are factors which count heavily on a military airplane. For this reason blowers will be found only in connection with heating systems in which high back pressures eliminate the use of scooped-in air, or in such airplanes which require ground heating. In the latter case there is, of course, no air available through ram and a blower must be incorporated. Planes so equipped may use the blower during flight in lieu of a scoop once its weight must be carried anyway. However, the current drain of the blower motor makes it often necessary to still rely on scoops during flight. Frequently, a suitable combination of two or all of the above described

schemes may furnish the best solution.

The blowers normally used on airplanes for supplying ventilating air on the ground or heater combustion air in flight, provide only relatively low pressures at small or medium quantities. At high altitudes such blowers are unable to furnish the air in the quantities and at the pressures required for physical existence. Realizing that at about 35,000 ft above sea level, a blower must develop a pressure of approximately 20 in. of mercury in order to supply air at sea level pressure, it is easy to understand why sufficient air supply at such pressures is one of the most difficult problems of high altitude flying. In spite of that, blowers have been developed to meet these requirements and are successfully used as superchargers for pressurized cabins. Such cabins must be absolutely air tight and provided with automatically regulating pressure controls for both air inlet and outlet. In order to keep the burden of the supercharger to a minimum, the pressure within the cabin is kept only as high as that existing at from 6000 to 10,000 ft.

Cabin supercharging provides not only a positive means of sufficient air supply irrespective of altitude, without the need for draft causing scoops or cumbersome oxygen equipment, but also essentially constant air pressures. The rapid changes in altitude and, consequently, atmospheric pressures to which military fliers are exposed, are extremely harmful to the human body. Although the body can adapt itself to gradual changes of outside pressures to a remarkable degree, there are certain limits beyond which serious injury is sustained. In minimizing this effect, supercharging is the most logical solution for high altitude flight. On the other hand, the pressurized plane is very vulnerable to enemy fire since holes in the skin of the cabin, if numerous and large, would render the supercharger ineffective and require the crew to abandon the ship although it may otherwise be in perfect shape for flight and combat. For this reason, the great advantages of supercharging will be realized primarily by postwar high altitude aircraft.

Requirements of Heat Supply

The requirements of heat supply on a military airplane have grown far beyond the scope of heating of flight crews. Generally speaking, heat supply must be provided for one or more of the following purposes: (1) heating of flight crews; (2) heating of passengers; (3) heating of accessories; (4) anti-icing; (5) anti-frosting; (6) ground heating.

The heat quantities needed to meet these requirements are difficult to calculate. Conventional formulas and factors do not hold true at the altitudes, speeds, and temperatures incidental to military flying. Most war planes have relatively little or no heat insulation, further aggravating calculations and requiring heat quantities far in excess of what would be expected. On the other hand, there are two factors which offer some relief. First, military aircraft do not require the narrow control and range of temperatures specified for commercial air liners. Keeping in mind that the task of military comfortization is the elimination of discomforts rather than the creation of comforts, only as much heat must be furnished to flight crews as is necessary to keep them physically fit. Somewhat more rigid specifications apply to transports, ambulance planes, and the like. However, these planes are usually well insulated and permit at least approximate calculations of heat supply. Neither do accessories require very accurate heat control as long as their temperature is kept above about 40 F and below a considerably higher upper limit. There are, of course, exceptions, such as for some photographic equipment, where too low a temperature will destroy the sensitivity of the film and too high a temperature will cause fogging.

A second factor which assists in establishing heating quantities is a collection of empirical values which has been accumulated during the past three years of aerial warfare. Thus, for instance, 10 to 20 Stu (standard temperature unit equalling 1000 Btu per hr) usually suffices for the heating of individual accessories. The choice between the lower and upper limits is governed by such factors as location of the accessory, service ceiling, and speed of the plane, etc. Anti-

Early model of an internal combustion altitude heater, with an automatic high altitude control to keep the fuel-air ratio constant. Note the air scoop

icing requires about 1 Stu per sq ft of anti-icing area, and heaters with capacities ranging from 60 to 100 Stu have been found to supply the cabin heating needs for medium sized planes.

The growing importance of anti-icing, ground heating, heating of instruments, gun breeches, etc., has resulted in a demand for heat capacities which are a multiple of what they were only a short while ago. Although existing airplane heating systems are not yet capable of meeting all of the needs and requirements of heat supply for military aircraft, a brief description of these systems will show the extraordinary work which has been done by American industry and the tremendous task which still lies ahead of it.

Airplane Heating Systems

The logical means for obtaining heat on an airplane is to utilize the large heat quantities available in the engine exhaust. However, while millions of Btu's are thus wasted, the incorporation of suitable heat exchangers in the tail pipes creates so many problems that this method is usually not very satisfactory. Exhaust heat exchangers are bulky, heavy, and often increase the back pressure in the exhaust pipe, thus decreasing the efficiency of the engine. Bullet holes through the heat exchanger permit the mixing of ventilating air with carbon monoxide, ground heating is not possible, and many fast and high flying planes have exhaust stacks which are too short for insertion of heat exchangers. In spite of these disadvantages, heaters of this type are used in several installations since they are adaptable for supply of large heat quantities.

Also utilizing the heat from the engine exhaust are the exhaust steam heaters, with boilers inserted into the exhaust pipe. Small quantities of water are fed into the boilers and instantaneously converted into steam which is piped to radiators distributed within the cabin. While this system eliminates the danger of carbon monoxide infiltration, it shares the other disadvantages of the exhaust hot air system. In addition to these, the hazards of steam lines in the cabin of a military plane are such as to make this system rather unsuited. One of its main difficulties is the design of a boiler which will stand up under the quenching action of the water. One of the photos shows a steam boiler which was turned from a solid piece of stainless steel although even this construction has not solved all problems. Heating glycol instead of steaming water in the boilers has proved a simpler problem but only at the cost of less and more complicated heat transfer. Nevertheless, exhaust steam heaters are still used quite extensively on war planes, and such systems have been employed on transports with some success.

Heat supply by means of electricity is another method which offers only a partial solution. Undoubtedly, this method is most convenient and efficient. On the other hand, 1 kw of electric energy produces only 3.4 Stu of heat so that enormous currents would be required, if electricity alone were to furnish all heating needs. In spite of that, electric heating can be profitably incorporated if small and concentrated heat quantities suffice, such as for electric flying suits which consume only a total of about 150 watts for helmet, suit, gloves, and boots. Although the use of such suits is limited, they have been widely employed with great success. Electrically heated covers and blankets have likewise been found effective in heating certain accessories.

A popular and widely used type of heating system is the internal combustion type in which a mixture of air and fuel—usually aviation gasoline—is burned and the heat thus generated transferred to ventilating air by means of fans or blowers. This system, too, has disadvantages and limitations. It requires fuel, electric current, and servicing. The presence of a flame within the cabin, although totally enclosed, and of a device producing carbon monoxide are hazards. On the other hand, these heaters are extremely flexible and adaptable to practically all conditions. They can be made small enough to serve as unit heaters and large enough for central heating systems. These advantages outweigh their disadvantages sufficiently to explain their popularity among comfortization engineers.

Internal combustion type heaters were originally introduced for automobile heating. Further developments resulted in the creation of a line of airplane heaters, ranging in size from the small unit heater, which draws its fuel-air mixture from the engine carburetor, to large heaters with the integral, gasoline operated power unit

The difficulties encountered in keeping internal combustion type heaters supplied with the correct fuel-air mixture at even the highest altitudes have resulted in the development of heaters which contain an automatic high altitude control which keeps the fuel-air mixture constant, irrespective of altitude. Such units furnish a heat output of over a quarter-million Btu per hr at a weight of only about 30 lb, which makes them well suited for anti-icing and similar purposes.

Accessories

Accessories and controls for aircraft heating and ventilating systems are probably in a much farther advanced stage of development than the heaters themselves. The explanation for that is that many accessories used on the ground could be easier adapted for aircraft than the existing ground heaters. It is interesting to note that, for instance, a complete line of aircraft insulating materials had been developed which for a number of years has greatly assisted in decreasing aircraft heating requirements. Although originally intended for soundproofing, these materials have proved very suitable for heatproofing and are used for these purposes quite extensively, although not yet generally enough to suit the airplane heating engineer. This applies also to ducting, air outlets, dampers, diffusers, and other conventional ventilating accessories which were redesigned for use on airplanes.

Among the controls proper, mention should be made of devices such as solenoid shutoff valves for internal combustion heaters which automatically stop the flow of the raw gasoline or the fuel-air mixture from the engine, if the heater is turned off or something goes wrong. Other controls permit au-

[*Concluded on p. 542*]

Testing Toxic Atmospheres

N. R. Bernz Explains the Methods of Determining the Impurities in Industrial Air, a First Step in a Program for Industrial Health Conservation

FOR HALF a century or more the United States has been looked upon by the rest of the world as an industrial giant, a nation in which industrial production has surpassed every other line of endeavor. At no time, however, has the productive capacity of this country meant more to us and to the rest of the world than it does today.

We can afford no interference to operations of our industrial plants. Prevention of accidents and occupational disease becomes our duty.

Metal Fumes and Vapors

Lead

Exposure to this metal occurs very extensively in nearly all types of manufacturing. The most frequently encountered forms of lead are fumes, dust, and dispersed pigments. These occur around lead melting operations, soldering, welding of metals covered with lead bearing paints, and in spray painting work.

Sampling of lead contaminated atmospheres is usually done either by means of the impinger or by the electrostatic precipitator. When the impinger is used, as is frequently the case when investigating spray painting and many other types of work involving lead dispersion, the sampling liquid may be either distilled water or dilute nitric acid.

For sampling of metal fumes, the impinger has a lower collecting efficiency than the electrostatic precipitator, which should be taken into consideration when comparing results obtained on samples collected with the two instruments. [See Efficiency of Impingers for Collecting Lead Dusts and Fumes, R. I. 3401, U. S. Bureau of Mines, 1938.]

Regardless of the collection method used, the final evaluation of the amount of lead present is done in the laboratory by various analytical methods, the description of which is beyond our scope here. It probably should be emphasized, however, that although some of these methods are highly sensitive and the experienced analysts usually well-trained to handle minute quantities of lead in their work, it is preferable to take large air samples wherever possible to facilitate the laboratory work. With the large impinger and the electrostatic precipitator, with sampling rates of 1 and 3 cfm of air, respectively, this is not a problem. With the midget impinger, on the other hand, with a sampling rate of only 0.1 cfm, this becomes a tiresome task, especially if the hand cranked instrument is used.

Let us take, for example, a case in which the atmospheric lead dispersion is just about on the border line of the safe limit, i.e. 1.5 mg per 10 cubic meters of air. For a 30 min sample with the midget impinger, only 3 cu ft of air have been handled. This represents only 0.013 mg of lead in the air sample, which evidently requires a fairly sensitive analytical method and careful handling for a successful completion of the test.

Cadmium

The United States Public Health Service suggests as a safe limit with respect to toxicity of cadmium fumes a concentration of 1 mg per 10 cubic meters of air. [See Cadmium Poisoning, Public Health Reports, 57, 17, April 24, 1942.]

The metal is used extensively as a coating of iron and steel for rust prevention, as well as in structural steel to impart certain properties. Exposures to cadmium and cadmium fumes may, therefore, be encountered in such operations as electroplating, welding of cadmium bearing iron and steel, as well as many other processes where work involves cadmium plated articles. Some readers are probably familiar with the cases of cadmium intoxication in a plant in Ontario, Canada, a few years ago, when 14 persons were poisoned—two fatally—during annealing of cadmium plated rivets. [Canadian Public Health Journal, 1938, 29, 19-26.]

As in the case of lead, sampling for cadmium fumes or dust may be done either with the impinger (with water as the collection medium) or by the electrostatic precipitator and the samples evaluated in the laboratory by gravimetric or colorimetric analytical methods.

Mercury

The war emergency has greatly accelerated the use of mercury, not only in our ammunition works, but also in many other plants directly or indirectly connected with war industry. In some cases entirely new uses have been introduced for this metal. For example, a recent development is an antifouling paint containing mercury, now used in our shipyards. Application of this mercury bearing paint by means of

Health Conservation

In a discussion at a meeting of the National Safety Council, Mr. Bernz gave a brief description of some of the more commonly encountered toxic substances in war industries, and methods for their evaluation. The material on dusts published in the May HPAC and that on gases in the September issue were taken from his paper; this month, metal fumes and vapors, solvent vapors, and acids are discussed.

Unless properly controlled, exposure to these materials may result in ill health among industrial workers with accompanying absenteeism and interference with war production. The control of the industrial poisons should, therefore, be an integral part of an extensive program of industrial health conservation. Such a program is of prime importance at a time when every piece of manufactured goods plays an important part in winning the war, and is of interest to ventilation engineers because ventilation is the principal method of control.

Mr. Bernz, a consulting engineer, is a member of HPAC's board of consulting & contributing editors.

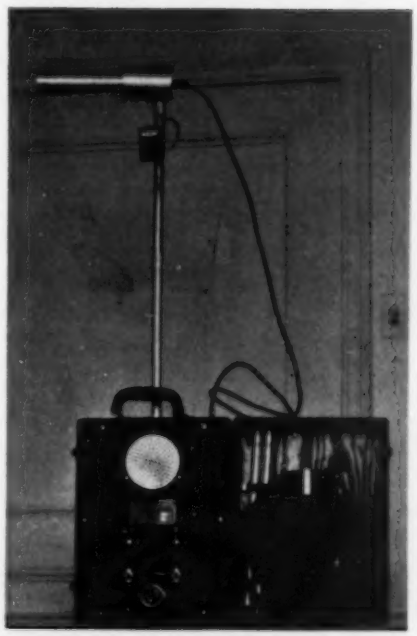
spraying naturally introduces a serious exposure to mercury poisoning and calls for careful control; this applies also to the manufacture of the paint. Due to the great demand for mercury and the shutting off of foreign supplies, old mercury mines have been reopened so that refining of this metal with accompanying occupational disease hazards has expanded considerably.

The toxic properties of mercury as a respiratory hazard when present in the form of vapors or in a finely divided metallic state are probably fairly well-known to most men concerned with industrial health. A safe limit, toxicologically, of about 2 mg per 10 cubic meters of air appears to be generally accepted for inhalation exposures. Although the metal has a relatively low vapor pressure at ordinary temperatures, investigations have shown that sufficient vapors are emitted to produce a mercury hazard in rooms where this material is used in metallic form.

A number of methods are available for the evaluation of mercury vapors in air. One of the most expedient procedures is probably by means of the Nordlander apparatus utilizing a selenium sulfide test paper, the color of which darkens in the presence of mercury. The amount of mercury present is estimated by comparing the degree of darkening with a standard color chart.

Another more recently developed method involves an optical instrument based on the opacity of mercury vapors to ultraviolet light of a certain wave length. In this instrument, therefore, when ultraviolet light of a specific wave length is directed toward a phototube, interfering mercury vapor will reduce the light received by the phototube and consequently also its current flow, which in turn is calibrated in terms of mercury concentration. This instrument is not specific, as it is subject to other light intercepting media such as smoke and fog.

There are also other methods for determinations of mercury, entailing condensation of the vapors and subsequent electrolytic deposition of the metal, chemical reaction methods, etc. The first two mentioned above, however, are the most expedient and yield immediate results during the field investigations.



Sampling of lead contaminated atmospheres is usually done by means of the impinger (top) or by the electrostatic precipitator (bottom)

Solvent Vapors

Benzene (Benzol), Toluene, and Xylene

These three aromatic hydrocarbons are widely used as industrial solvents and ingredients in a number of chemical reactions. Toluene, for example, is an important raw material in ammunition manufacturing, especially in the production of trinitrotoluene. With the increased demand for toluene and the corresponding scarcity of this material, benzene has been rapidly taking its place as a solvent in many industries. Xylene, which besides being an important solvent, also enters as a raw material in certain chemical processes associated with war industry and therefore is used in great quantities. For instance, in a plant I visited recently, xylene is used in the production of a certain type of resin, which in turn is employed in an article manufactured for the Army.

All these three materials are classified as industrial poisons, although there appears to be some confusion as to the relative toxicity of each. Benzene is generally considered as the worst offender, although this may not be due to a greater toxicity of the material *per se* but to the fact that it has a higher vapor pressure than the other two so that for a given temperature more of it will be found in the air. However that may be, the toxic effect of all of them, once dispersed in the air, is generally recognized and therefore the need for strict control wherever they are used is indicated.

For the evaluation of these materials some chemical as well as physical methods are available. Most of these, however, are complicated and cumbersome, involving such operations as nitration by bubbling the air through nitric acid with subsequent colorimetric determination, or condensation of the vapors followed up by laboratory analytical procedures for the final evaluation.

While methods of this type may be satisfactory for scientific purposes, for routine sampling in control work in industrial plants, a combustible gas indicator is far more expedient. Most of these devices, used primarily for fire prevention work, are designed to read to within 1 per cent of the lower explosive limit of the gas or vapor under test. For the above substances with lower explosive limits around 1 per cent by volume, this means that concentrations down to 100 ppm can be detected, which is

approximately the accepted toxic limit for these solvents. For benzene with a safe limit of 75 ppm [American Standards Association: Benzene, allowable concentration. Z 37.4, 1941] a modified combustible gas indicator has been placed on the market, which measures concentrations ranging between 0 and 1000 ppm. A spectroscopic method for determination of benzene and toluene in air has been described by Cole. [Journal of the Optical Society of America, 32, 304-306, May, 1942.]

Chlorinated Hydrocarbons

Of these, trichloroethylene and carbon tetrachloride are probably most frequently found. They are used extensively as metal cleaning agents, the former in regular degreasing machines on a production basis and the latter for work of a more occasional nature. These materials with their grease dissolving properties are regarded by medical authorities as very injurious to the fatty tissues of the human body.

As in the case of other substances referred to above, there are chemical methods for quantitative determination of vapors from these materials, but they are mostly too cumbersome for routine sampling. Optical instruments are available, however, for rapid evaluation of such vapors dispersed in the air. The best known of these is probably the portable interferometer in which the difference between the refraction of air (the comparison substance) and that of the gas mixture to be examined is measured. This difference is calibrated in terms of concentration of the gas or gases under observation. Naturally, the same readings will be obtained for all gas mixtures resulting in the same refractive index, so the instrument is therefore not specific. With information, however, as to the type of air contaminant concerned in a particular problem it is an exceedingly useful instrument applicable to the investigation of a great variety of gases and vapors.

Carbon Disulfide

This substance, which at ordinary temperatures occurs as a liquid with a high vapor pressure, generates toxic vapors for which relatively low safe limits have been suggested by various authorities. Russian investigators have recommended a threshold limit of only 3 ppm for prolonged exposures, while the British Department of Scientific and Industrial Research has suggested a value of 10 ppm and our own State of Massachusetts, 20 ppm. While there is a wide divergence between these values, they all tend to indicate the potential dangers connected with exposure to vapors of carbon disulfide.

Although this solvent may be encountered in a great many industrial operations, it is found primarily in the viscose and rubber industries, where it constitutes an important raw material.

For evaluation of these vapors, the Industrial Hygiene Foundation recommends drawing the air through an alcoholic potassium hydroxide solution to form potassium ethyl xanthate which is determined iodometrically. The British Department of Scientific and Industrial Research uses a colorimetric method consisting of bubbling the air through diethylamine and copper acetate forming a colored compound the intensity of which is compared with standards. In view of the inflammability of these vapors, a rapid method for their evaluation in high concentrations would be by means of a combustible gas indicator. Unfortunately, however, the sensitivities of these instruments as built at present are not low enough to get within the physiological safety range of this material.

Aniline

This is a toxic liquid which can be absorbed through the skin and which in spite of its relatively low vapor pressure emits sufficient vapors at ordinary temperatures to present a respiratory hazard. Safe limits of the order of 2.5 ppm (Russian) to 10 ppm have been recommended for inhalation exposures in connection with this material. It is encountered primarily in the dye industry and rubber works.

For testing of aniline vapors the Industrial Hygiene Foundation recommends bubbling the air sample through 10 per cent sulfuric acid and refers to a chemical method for the quantitative analysis.

The standard method adopted by the British Department of Scientific and Industrial Research for evaluation of aniline vapors, consists of drawing the air through dilute hydrochloric acid after which the determination is made colorimetrically.

Acids

In this group, probably nitric, chromic, hydrofluoric, hydrochloric, and sulfuric acids are those most commonly encountered. Of these, nitric acid has been discussed under another heading. Exposures to chromic acid resulting in chrome ulcers and the perforated nasal septum are frequently found around chromium plating tanks. A safe limit of 1 mg per 10 cubic meters of air has been established for chromic acid which in electroplating work occurs as a mist over the plating bath. Hydrofluoric and hydrochloric acids also exist in gaseous form as hydrogen fluoride and hydrogen chloride respectively. A safe limit of 3 ppm has been suggested for the former, while it has been set at 10 ppm for the latter.

Sampling for nitric, chromic, and sulfuric acids is usually done by bubbling through a sodium hydroxide solution; hydrofluoric acid through potassium hydroxide; and hydrochloric acid through glycerol-potassium carbonate-water solution. For the final laboratory evaluation refer to standard methods of the American Public Health Association.

ENAMELED DUCTS IN CANDY PLANT

Modern air conditioning equipment is utilized by Helen K. Salsburg Candies, Wilkes-Barre, Pa., in the production, packaging, and storage of high quality candies.

Clean Appearance

An interesting aspect of the installation is the galvanized sheet metal duct work for the air distribution system, which was enameled white before being erected. This eliminated any necessity for painting the duct work after erection and the possibility of paint odor being absorbed by the candy. The enameled finish also gives the duct work a very clean appearance and makes washing easy.

Things to Remember When

Using Methyl Chloride in Place of "Freon-12"

Shortage of "Freon" Due to War Results in Use of Methyl Chloride as Substitute; Watch These Points

ALTHOUGH LITTLE information is generally available regarding the conversion of refrigerating systems from "Freon-12" to methyl chloride, many users must of necessity make this conversion because the WPB has cut down the supply of "Freon-12" for civilian use. This article is an attempt—from the limited experience generally available—to inform operators and users of refrigerating machinery of points to be watched in making these conversions successfully.

Hazards

Those who contemplate charging refrigerating systems with methyl chloride must realize that methyl chloride is toxic and inflammable. For this reason the American Standard Safety Code for Mechanical Refrigeration — after which many local codes are patterned—forbids the use of methyl chloride in *direct expansion* air conditioning systems in public institutions such as hospitals or court houses; in public assembly places such as theaters, auditoriums or libraries; in residential occupancies such as hotels, clubs, and dormitories. In commercial installations such as stores and doctors' offices, direct expansion air conditioning systems are permitted providing the entire refrigerating system does not contain more than 20 lb of methyl chloride. There are no restrictions on industrial occupancies unless the number of employees above the first floor exceeds one per 100 sq ft of floor area.

Refrigerating systems for food preservation and storage are also seriously limited as to the amount of methyl chloride that may be used. In institutions such as hotels, dormitories, etc., unit refrigerating systems may not contain more than 6 lb of methyl chloride. In public assembly places, no more than 12 lb may be contained in the system.

Because of the limitations on the use of methyl chloride in direct expansion air conditioning systems and in refrigerating systems, those who intend converting to methyl chloride should first check the American Standard Safety Code for Mechanical Refrigeration which can be purchased from the American Society of Refrigerating Engineers, 50 W. 40th St., New York, N. Y., for 20c.

Wartime restrictions have sometimes made it difficult for this bird to keep his perch on the frosty block promising "cool inside." One problem has been the shortage of "Freon" for civilian use; use of methyl chloride as a substitute is discussed here.

Methyl chloride should not be charged into systems where it will come into contact with aluminum or zinc. In the presence of even minute quantities of water it will rapidly corrode these metals. In addition in the presence of slight traces of water, methyl chloride in contact with aluminum will form dangerous, spontaneously inflammable compounds. For these two reasons, methyl chloride should not be used in any system where it will contact aluminum. Aside from aluminum, zinc, and magnesium, methyl chloride is believed to be inert toward other materials commonly used in "Freon-12" refrigerating systems.

To remove any trace of moisture that may be present in the system, installation of a dryer containing a material like silica gel or activated alumina is desirable. Activated alumina in the form used in the dryer will not, it is understood, react with the methyl chloride, and will effectively remove any moisture that may be present.

Where, due to the emergency, methyl chloride must be used in an air conditioning system, the use of methyl chloride "A" is preferable to the use of straight methyl chloride. Methyl chloride "A" is simply standard methyl chloride to which has been added 1 per cent of acrolein. Acrolein is irritating to the throat, nose, and eyes. As a result, if even a minute quantity of the methyl chloride-acrolein mixture leaks, people will be warned.

Pressure Testing

Because methyl chloride is both toxic and inflammable, it is a wise precaution to make sure that the piping system is absolutely tight before the methyl chloride is added.

Whereas a piping system containing "Freon" can be checked for leaks easily and quickly by means of a halide torch, the use of such a torch for testing methyl chloride presents a definite hazard. Enough methyl chloride may escape into a room through a leak to form an explosive mixture which will be ignited by the open flame of the halide torch. For this reason the piping system should be checked for leaks *before* the methyl chloride is added.

Watch It!

The importance of "Freon" in the production of certain war materials means that there is a shortage for civilian use in refrigerating and air conditioning installations, and the WPB's conservation order M-28 controls the use of this refrigerant. As a consequence, methyl chloride is being used as a substitute for "Freon" in existing installations. . . . Naturally, in using a different refrigerant in place of the one for which a system was designed, certain precautions must be observed because the properties of the two gases are not the same. This article outlines some of the important points of difference which must be remembered. . . . Local codes and inspection requirements must also be observed, as must the individual characteristics of any specific installation. The change should not be made by an inexperienced person, obviously.

Inasmuch as most users will want to save as much of the "Freon" as possible, the "Freon" should be pumped out of the system into drums. Remove "Freon" until the pressure inside the system has been reduced to between zero gage and 10 in. of vacuum. At this pressure, enough "Freon" will be left in the system for testing purposes. Now build up the pressure for testing by adding *anhydrous* carbon dioxide (CO_2). Run the compressor for a few minutes to mix the "Freon" and carbon dioxide thoroughly. Now carefully go over the entire refrigerating system with a halide torch. Even a trace of "Freon" in the carbon dioxide escaping through a leak will cause the flame to turn green. Incidentally, air is not satisfactory for building up the pressure for testing purposes because moisture is likely to condense from the high pressure air inside the piping system. Water inside of refrigerating systems can cause a number of difficulties.

If anhydrous carbon dioxide cannot be obtained, the CO_2 drum should be allowed to stand for about 24 hr with the bottom tipped up. Any moisture in the drum will then drain to the valve end where it can be blown off before the gas is used. However, the use of anhydrous CO_2 is preferable.

When charging carbon dioxide into the system, be sure to supply it slowly and to use a pressure regulating valve. It is dangerous to control the flow of gas otherwise because the pressure inside the drum is high, over 1000 psi. The pressure inside the refrigerating system should be built up to about 150 psi to test for leaks.

The tube from the CO_2 drum should be connected into the low side of the system; that is, connected into some point between the discharge of the expansion valve and the suction of the compressor. In this way the gas will be able to flow around through the entire piping system. The gage port on the back-seated suction valve at the compressor is usually a convenient place for making the connection. If, as is frequently the case, the CO_2 connection is made into the high side — into some point between the discharge of the compressor and the inlet side of the expansion valve—the test pressure will not build up to the maximum in the low side.

The reason for this is that the discharge valve on the compressor prevents the gas from flowing back through the compressor into the suction line. Furthermore, an expansion valve set for 10 F superheat and in a 70 F room will shut off as soon as the pressure inside the piping system reaches about 60 psi. Consequently, whereas the pressure on the high side of the system would be 150 psi, the pressure on the low side would be only 60 psi, which would be too low to detect small leaks. For this reason, in making pressure tests the connection from the CO_2 drum should always be connected into the low side so that the gas can flow through the compressor and into the entire refrigerating system.

After all leaks have been repaired and the system is found to be tight, the CO_2 can be released to the atmosphere. The piping system should then be evacuated to a vacuum of 29 in., or better if possible, by means of a separate vacuum pump. The vacuum pump should be allowed to run for about 2 hr after the gage first shows that the vacuum in the system has fallen to 29 in. After the system has been thoroughly evacuated, the methyl chloride can be charged into the refrigerating system.

After the system has been pressure tested, it is desirable to drain the old oil from the crankcase. Do not replace the oil immediately. First evacuate the system down to 29 in. as previously mentioned. After the system has been evacuated and enough methyl chloride has then been added to increase the pressure to about 10 in. of vacuum, a new charge of fresh, dry oil should be drawn into the crankcase.

Refrigerating Capacity

The capacity of a refrigerating system charged with methyl chloride is theoretically about the same as the capacity of the system when charged with "Freon." In actual practice it is probable that a system charged with methyl chloride will show slightly less capacity than when charged with "Freon." The exact reduction is difficult to estimate, but it is probably in the nature of about 5 per cent. The reduction in capacity is due to the fact that the temperature of the compressor cylinders runs considerably higher when pumping methyl chloride than when pumping "Freon." As a result the volumetric efficiency of the compressor with methyl chloride is lower than the volumetric efficiency with "Freon."

In some few cases, depending upon the design of the compressor, it may be necessary to make provisions for cooling the cylinder heads by means of a forced draft of air. In a system operated at 40 F suction and 100 F condensing temperature, the theoretical temperature of the gas discharged from the "Freon" compressor is only 108 F, whereas for methyl chloride it is 158 F, an increase of 50 F. Consequently much hotter cylinders and particularly much hotter heads can be expected when the compressor is pumping methyl chloride than when it is pumping "Freon."

Thermostatic Valves

Thermostatic valves charged with "Freon" can in many cases be used in methyl chloride systems. However, the superheat setting of the "Freon"-charged valve when operating on a methyl chloride system will be reduced by roughly about 9 F. For example, a "Freon"-charged valve which has been adjusted for a 10 F superheat will maintain only about 1 F superheat when used to control the flow of methyl chloride. For this reason, the superheat setting of a "Freon"-charged valve must be increased when used in methyl chloride systems. To obtain the same superheat with methyl chloride as was formerly obtained with "Freon," the superheat setting of the valve must be raised by increasing the spring tension.

It is possible that after the spring tension on the valve has been increased to the maximum possible, the superheat obtained with methyl chloride will still be smaller than was formerly obtained with "Freon," in which case too much liquid may be admitted to the evaporator coil. One remedy for this is to obtain from the manufacturer a new, heavier spring to be installed in the valve.

Another difficulty is that valves selected for a "Freon" system will be much too large for a methyl chloride system of the same tonnage. The reason for this is due to the much smaller *weight* of refrigerant that needs to be circulated with methyl chloride for any given tonnage. For example, with a 40 F evaporator and a 100 F condensing temperature, 3.88 lb of "Freon-12" must be circulated per minute per ton, whereas only 1.34 lb of methyl chloride is needed.

It is possible that some thermal valves will be satisfactory after the superheat setting has been set up as high as possible. However, in other cases, erratic operation may be experienced. Even with an increased superheat setting, the valve may still be too large. The valve may hunt, alternately flooding and starving the coil.

Remember that by increasing the superheat setting of a "Freon"-charged valve, you are only providing a normal superheat for operation with methyl chloride. For example, a "Freon"-charged valve set for a 10 F superheat will operate with only a 1 F superheat when controlling methyl chloride. By increasing the superheat setting of the valve, you are only restoring the superheat setting to approximately 10 F with methyl chloride. Perhaps the valve is small enough so that it can throttle down and prevent the methyl chloride from flooding the evaporator, but it is also possible that the valve may still be too large and every time it cracks open it may flood the evaporator.

One cure is to install a smaller orifice in the valve. Another cure is to reduce the pressure difference across the thermal expansion valve by installing a hand-set valve ahead of the thermal valve. By closing the hand-set valve down slightly, the pressure difference across the expansion valve can be reduced, which in turn will reduce the capacity of the expansion valve. By throttling the liquid in two stages, the capacity of the "Freon" thermal valve can be reduced until its operation is reasonably satisfactory when controlling methyl chloride.

The hand-set valve should be nearly wide open because some expansion of the liquid will take place with a consequent increase in the specific volume of the liquid-gas mixture going to the expansion valve. Consequently only a small decrease in upstream pressure will be enough to lower the capacity of the thermal expansion valve. However, if the liquid is very much subcooled—which is rare—no flashing will occur in the hand-set valve and a larger reduction in pressure may be necessary to decrease the capacity of the expansion valve.

Suction Pressure Switch

Occasionally a suction pressure switch is used on water chillers as a safety to prevent freezing. At 32 F, the pressure in the evaporator with "Freon-12" would be 30 psi gage. The suction pressure switch would be set to shut off the compressor at, say, about 34 psi gage corresponding to a suction temperature of 36 F. If the pressure switch is not readjusted when methyl chloride is substituted, difficulties may be experienced with short cycling due to the safety control. At 34 psi the suction temperature of methyl chloride would be over 46 F. Consequently if the compressor is to cut off at the same suction temperature of 36 F with methyl chloride, the pressure switch should be readjusted to cut off at slightly over 25 psi gage.

Refrigerant Piping

When designing *new* systems the pipe sizes required for "Freon-12" are larger than those required for methyl chloride. For this reason all of the pipe sizes in a "Freon" system will be adequate when methyl chloride is substituted for the "Freon." The pressure drops throughout the system will be lower than when "Freon" is used—a decided advantage.

Erroneous conclusions have been drawn from the fact that the pipe sizes required for "Freon-12" when designing new systems are larger than the pipe sizes for methyl chloride. Warnings have appeared to the effect that difficulties might

Points to Remember

1) Methyl chloride is toxic and inflammable.
2) Do not use methyl chloride in systems where it will come in contact with aluminum or zinc.
3) Change the oil in the compressor.
4) Test the system for leaks BEFORE charging with methyl chloride.
5) For pressure testing, use anhydrous carbon dioxide with a small amount of "Freon." Use a halide torch.
6) Do NOT use a halide torch when testing for leaks AFTER the system has been filled with methyl chloride.
7) Increase superheat setting of "Freon"-charged thermal expansion valves to maximum. (New orifice may also be needed to reduce capacity of valve.)
8) Install dryer in liquid line.
9) Readjust suction pressure safety switch on water chiller if one is used.
10) Piping that has been properly sized for "Freon-12" will also be satisfactory for methyl chloride.

(Date)

R. COOPER JR., INC.:

The undersigned is ordering from you a quantity of methyl chloride for installation in equipment within our premises. We understand the inherent danger of this refrigerant and assume all risk incidental to its use, and hereby agree to protect and save you harmless from any and all claims of whatsoever kind arising from its use in our equipment.

(Signature)

A release form which one organization requires the owner to sign when methyl chloride is used.

be experienced with oil return from an evaporator due to the "lower velocity" of the methyl chloride in the suction line. The velocity of methyl chloride in a given size suction pipe will for all practical purposes be the *same* as the velocity of the "Freon-12" for the same refrigeration load. The *volume* of gas which must be circulated per ton of refrigeration is practically *the same* for both methyl chloride and "Freon" in the temperature ranges commonly used in ordinary commercial and air conditioning practice. If no difficulty with oil return was experienced with "Freon" in the piping, there should be no difficulty when methyl chloride is substituted.

With the same volume of gas flowing through the same suction line, the pressure drop with methyl chloride will be considerably less than with "Freon." The reason for this lower pressure drop is due to the much lower density of the methyl chloride vapor in the suction line. Thus, at 40 F the density of methyl chloride gas is only 0.44 lb per cu ft whereas for "Freon" the density is 1.26 lb per cu ft. This means that with the same volume, and consequently the same velocity in the suction line, the pressure drop with methyl chloride would be approximately one-third the pressure drop with "Freon." In both cases, however, the velocity would be the same.

Because of the lower density of the methyl chloride, suction lines for this gas can be much smaller than for "Freon" if both are selected for the same pressure drop. Inasmuch as pipe lines are commonly selected today on the basis of pressure drop instead of velocity, suction lines for methyl chloride can be smaller than for "Freon." However, in an existing piping system, the velocity of both methyl chloride and "Freon" will be practically the same for the same load, but the pressure drop when methyl chloride is substituted for "Freon" in the suction line will be considerably smaller.

Although changing the refrigerant charge from "Freon" to methyl chloride is, on the whole, not difficult, care must be exercised in the various procedures to obtain successful results. However, the greatest drawback to using methyl chloride in air conditioning systems does not lie in any technical difficulties in making the conversion, but is due rather to the toxicity and inflammability of the refrigerant itself.

QUARTERMASTER SCIENTISTS MAKE WEATHER OUR ALLY

The weather, once a fickle military ally at best, has been harnessed to the service of the United States Army by quartermaster corps scientists. In a quiet wing of the sprawling office of the quartermaster general in Washington, D. C., a small crew of military and civilian scientists has worked out charts showing the exact type of climatic conditions existing each month of the year in virtually every section of the world. Only a few localities have been omitted. Scores of maps of the world plaster the walls in this section.

These climatic studies have turned up some interesting facts. It has been shown, for example, that the weather in Tokio is virtually identical with that of Washington, D. C. And it has been found that the terrific Russian winters of which so much has been written are about like normal winters in northern Minnesota, North Dakota, and Maine. For closer comparison, Duluth is about on a par with Leningrad and Bismarck is quite similar to Moscow from a climatic standpoint.

Often it will be found that the weather in a particular locality of the world where military action is anticipated cannot be duplicated in the United States during the same month. However, it is seldom that a climate cannot be duplicated somewhere in America sometime during the year. Thus it often happens that for a September offensive in a far-away location, it is necessary to study and train under conditions existing in some part of the United States during February.

Armed with these climatic facts, the quartermaster corps has produced a scientifically developed clothing program. Knowing what the weather will be in any locality where fighting is in prospect, the corps proceeds to design clothing and equipage to meet those exact conditions.

SAVE FUEL BY HEATING EFFICIENTLY

MEASURING the FLOW of FLUIDS

William Goodman Gives Practical Data on the Use of Orifices and Manometers

FLOW OF a gas such as compressed air or of a vapor such as steam through an orifice can be calculated by the following modified form of equation 1, which was given on p. 413 of the August issue:

$$W = 31.5\ YKD^2\ \sqrt{pd} \quad \ldots\ldots [5]$$

Note that this equation is exactly the same as equation 1 except for the introduction of the expansion factor Y, which is introduced to take care of the expansion of the gas or vapor as it flows through the orifice. Because of the drop in pressure through the orifice, the density of the gas or vapor changes. However, in equation 5, d is always the density of the vapor or gas at the pressure *ahead* of the orifice; that is, at the *upstream* pressure tap.

Computing Flow of Gases and Vapors Through Orifices

Values of the factor Y for steam can be found by means of Tables 2 and 3, and for compressed air by means of Tables 2 and 4. The value of the factor N, which depends only upon the size of the orifice and the size of the pipe in which it is installed, is determined from Table 2. Then with the known factor N and with the ratio of the pressure difference to the absolute pressure ahead of the orifice known, the value of the expansion factor Y can be determined from either Table 3 or Table 4. (See footnote* below for the method of computing Tables 2, 3 and 4.)

For gases and vapors, the following modified form of equation 2, given on p. 415 of the August issue, is used to compute the Reynolds number to be used in determining the value of the flow coefficient K.

$$R_w = 11{,}940\ Y \frac{D}{u} \sqrt{pd} \quad \ldots [6]$$

Note that this equation also is exactly the same as equation 2 with the exception of the expansion factor Y. Note in equation 6, as in equation 5, that the density d is always the density of the gas or vapor immediately *ahead* of the orifice; it is *not* the density at the downstream side of the orifice.

The following example illustrates the method of computing the flow of either a gas or vapor through an orifice.

Example 5: A 3 in. diameter orifice is installed in a 6 in. standard weight pipe through which saturated steam is flowing. The pressure of the steam immediately ahead of the orifice is 124.3 psi ga. The measured pressure difference across the orifice is 7.1 psi. Flange taps are used. Find the weight of steam flowing.

Solution: Absolute steam pressure ahead of orifice = 124.3 + 14.7 = 139 psi absolute. Referring to the Keenan and Keyes steam tables, the temperature of saturated steam at 139 psi absolute is 352 F and its density is 0.308 lb per cu ft.

Referring to Fig. 2, on p. 463, August issue, at a temperature of 352 F, the viscosity of saturated steam is u = 0.0186 centipoises. The ratio of the pressure difference to the absolute pressure ahead of the orifice is p/P_1 = 7.1/139 = 0.051. Referring to Table 2 for a 3 in. orifice and a 6 in. pipe, N = 0.431. Referring to Table 3 for steam, for $N = 0.43$ and a pressure ratio of 0.05, $Y = 0.983$.

Using equation 6,

$$11{,}940 \times 0.983 \times \frac{3}{0.0186}\sqrt{7.1 \times 0.308} = 2{,}800{,}000$$

From Table 1, p. 462, September issue, the inside diameter of 6 in. standard weight steel pipe is D_1 = 6.065. Hence, the diameter ratio is $D/D_1 = 3/6.065 = 0.495$. Referring to Chart D, p. 414, August issue, which is for flange taps and a 6 in. pipe, for $D/D_1 = 0.495$ and for $R_w = 2{,}800{,}000$, $K = 0.622$.

Using equation 5, $W =$

$31.5 \times 0.983 \times 0.622 \times 3^2\sqrt{7.1 \times 0.308}$ = 256 lb per min, steam flowing through orifice.

The selection of orifices for a gas or vapor is exactly the same as for a liquid. The following modified form of equation 4, p. 461, September issue, is used:

$$Z = \frac{W}{Y\sqrt{pd}} \quad \ldots\ldots [7]$$

Equation 7 is the same as equation 4, except for the addition of the factor Y. When using equation 7 to select an orifice for a gas or vapor, the factor Y can be computed because both the pressure ahead of the orifice and the given pressure difference are known. Factor Y can then be computed in exactly the manner illustrated in example 5. After Y has been computed, equation 7 is used in exactly the manner illustrated by example 3, p. 462, September issue, and the resulting orifice selection can then be checked by the method illustrated in example 4. The only difference between the method used for gases and vapors and the method used for liquids is in the introduction of the expansion factor Y in equations 5, 6, and 7.

Measuring Pressure Difference Across Orifice by Manometer

For most of the purposes discussed in this article, mercury

*According to the ASME publication, Flow Measurement—1940, the expansion factor Y for an orifice may be calculated from the following empirical equation:

$$Y = 1 - \left[0.41 + 0.35\left(\frac{D}{D_1}\right)^4\right]\left(\frac{p}{P_1}\frac{1}{k}\right) \quad \ldots\ldots [a]$$

Let $N = \left[0.41 + 0.35\left(\frac{D}{D_1}\right)^4\right]$ ..... [b]

The values in Table 2 were computed from [b].

$$Y = 1 - N\left(\frac{p}{P_1}\frac{1}{k}\right) \quad \ldots\ldots [c]$$

Values in Tables 3 and 4 were computed from [c]. For air the value k = 1.4 was used, and for steam k = 1.3. The expansion factor Y for any other fluid can be computed by using the correct value of k in equation [c] above.

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Table 2—Values of N for standard weight steel pipe

Orifice Diameter Inches D	Nominal Pipe Size — Inches								
	2	2-1/2	3	4	5	6	8	10	12
5/8	0.413								
3/4	.416	0.413							
7/8	.421	.416							
1	0.429	0.419	0.414						
1-1/8	.441	.425	.416						
1-1/4	.457	.433	.420	0.413					
1-3/8	.479	.444	.424	.415					
1-1/2		0.458	0.430	0.417					
1-5/8		.476	.438	.419	0.414				
1-3/4			.447	.422	.415				
1-7/8			.459	.426	.417	0.413			
2			0.473	0.431	0.419	0.414			
2-1/8			.491	.437	.421	.415			
2-1/4				.444	.424	.417			
2-3/8				.452	.427	.418			
2-1/2				0.462	0.431	0.420	0.413		
2-5/8				.473	.436	.422	.414		
2-3/4				.486	.441	.425	.415		
2-7/8					.447	.428	.416		
3					0.454	0.431	0.417		
3-1/4					.470	.439	.419	0.414	
3-1/2						.449	.422	.415	
3-3/4						.461	.426	.416	0.413
4						0.476	0.431	0.418	0.414
4-1/4							.437	.421	.415
4-1/2							.444	.423	.417
4-3/4							.452	.427	.418
5							0.462	0.430	0.420
5-1/2							.485	.440	.425
6								.452	.431
6-1/2								.468	.439
7								0.488	0.449
7-1/2									.462
8									.477
8-1/2									.496

manometers are likely to be used. Although the basic formula that is given here may be used regardless of the kind of liquid in the manometer, the discussion in this section will be confined to mercury manometers.

A manometer is a most convenient instrument for measuring the *difference* in pressure across an orifice. Fig. 4 shows, in its simplest form, a manometer connected to an orifice. If water is flowing through the orifice, obviously the pipe connections to the manometer and the space in the manometer above the mercury will also be filled with water. The rise, h, of the mercury column in one leg of the manometer is due not only to the pressure difference across the orifice, but also to the weight of water between lines *1-1* and *2-2* in Fig. 4. In other words, the weight of the column of water, whose height is also h, pushes the mercury down in one leg of the manometer and up in the other. Consequently, the rise h of the column of mercury is due both to the pressure difference across the orifice and to the weight of the column of water of height h. Note that it is only the weight of the column of water h which affects the rise of the mercury. The weight of water in the pipe connections and in the manometer above the line *1-1* of Fig. 4 has no effect because the weight of water above line *1-1* on one side of the manometer is balanced by an equal weight on the other side.

The formula† for computing the pressure difference from the rise h of the mercury column is

$$p = \left(\frac{d_H - d_L}{1728}\right)h \quad \ldots\ldots [8]$$

For computing the rise h for a given pressure difference, equation 8 can be written:

$$h = \frac{1728\,p}{d_H - d_L} \quad \ldots\ldots\ldots [8a]$$

Note that d_H is the density of the heavy liquid in the manometer and d_L is the density of the lighter liquid in the manometer between lines *1-1* and *2-2*. The symbol d_L *never* represents the density of the liquid flowing through the orifice. As will be seen later, it is important that this difference be kept in mind or errors will result.

If mercury is used in the manometer, $d_H = 845.6$ lb per cu ft.

Example 6 illustrates the use of equation 8.

Example 6: A manometer, some distance from the orifice, is situated in a room at a temperature of 68 F. The temperature of the water in the manometer will also be at this temperature. Water at a temperature of 68 F weighs 62.3 lb per cu ft. The rise of the mercury manometer is 15.5 in. Find the pressure difference across the orifice.

†Referring to Fig. 4, the forces acting on each leg of the manometer must be equal, or

$$144\,P_1 + \frac{h}{12}d_L = 144\,P_2 + \frac{h}{12}d_H \quad \ldots [a]$$

$$P_1 - P_2 = \left(\frac{d_H - d_L}{1728}\right)h \quad \ldots [b]$$

But $$P_1 - P_2 = p \quad \ldots\ldots\ldots [c]$$

Hence, $$p = \left(\frac{d_H - d_L}{1728}\right)h \quad \ldots [d]$$

This is equation 8 of the text.

SYMBOLS

D = throat diameter of orifice in plate, in.;
D_1 = inside diameter of pipe in which orifice is installed, in.;
d = density of fluid at pressure P ahead of orifice, lb per cu ft;
d_H = density of heavy liquid in manometer, lb per cu ft;
d_L = density of light liquid above heavy liquid in manometer, lb per cu ft;
h = height of mercury column in manometer, in.;
K = flow coefficient of orifice;
k = ratio of specific heats of gas or vapor;
N = a constant used in determining the expansion factor Y;
P_1 = absolute pressure of fluid ahead of orifice, psi absolute;
P_2 = absolute pressure of fluid after orifice, psi absolute;
p = pressure difference across orifice, psi;
R_w = modified Reynolds number for selecting flow coefficients;
u = viscosity of fluid flowing through orifice, centipoises;
W = weight of fluid flowing through orifice, lb per min;
Y = expansion factor of orifice;
Z = orifice constant.

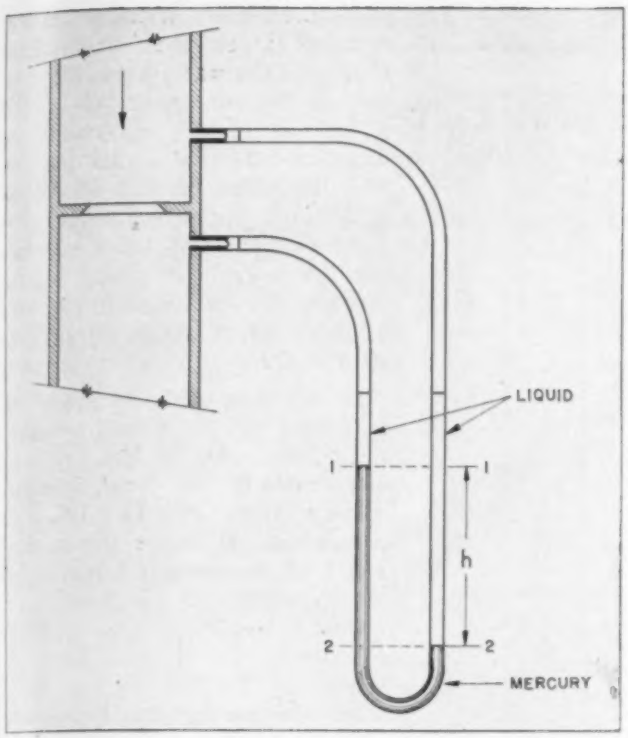


Fig. 4—Diagrammatic illustration of orifice and manometer for measuring flow of liquids or gases

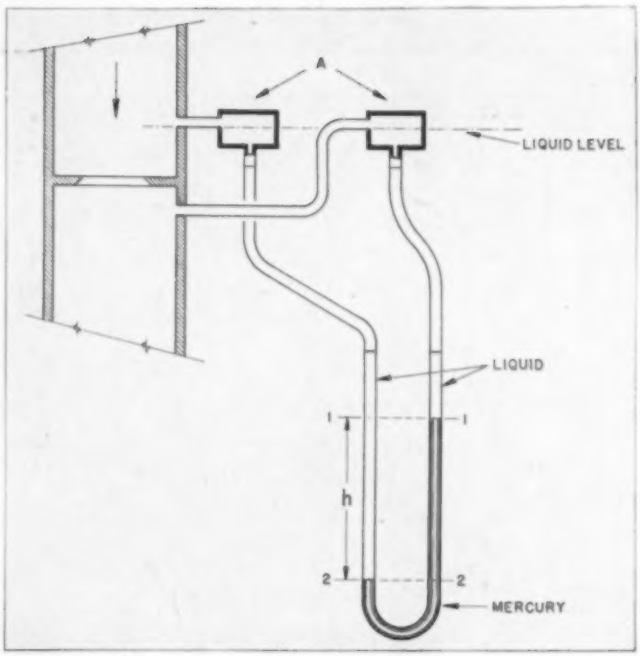


Fig. 5—Diagrammatic illustration of orifice and manometer for measuring flow of steam or other condensable vapors

Solution: Using equation 8,

$$p = \left(\frac{845.6 - 62.3}{1728}\right) \times 15.5$$
$$= 0.4533 \times 15.5$$
$$= 7.03 \text{ psi}$$

The pressure difference as computed in example 6 would be used in equations 1, 2, and 4 or equations 5, 6 and 7 for computing the weight of fluid flowing through the orifice.

It is important to remember that d_L is the density of the liquid above the mercury in the manometer and never the density of the liquid flowing through the orifice. For example, a manometer might be situated a long way from the orifice. Even though hot water under pressure at a temperature of, say, 320 F might be flowing through the orifice, if the manometer were far enough away from the orifice, the water above the mercury in the manometer would be substantially at room temperature because there is no flow through the manometer. The density of water at 320 F is 56.7 lb per cu ft. Nevertheless, the density of water at 68 F, namely 62.3 lb per cu ft, would be used in computing the pressure difference across the orifice by means of equation 8 in spite of the fact that 320 F water was flowing through

Table 3—Values of Y for steam ($k = 1.3$)

$\frac{p}{p_1}$	N									
	0.41	0.42	0.43	0.44	0.45	0.46	0.47	0.48	0.49	0.50
0.00	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000
.01	.997	.997	.997	.997	.997	.996	.996	.996	.996	.996
.02	.994	.994	.993	.993	.993	.993	.993	.993	.992	.992
.03	.991	.990	.990	.990	.990	.989	.989	.989	.989	.988
.04	.987	.987	.987	.986	.986	.986	.986	.985	.985	.985
0.05	0.984	0.984	0.983	0.983	0.983	0.982	0.982	0.982	0.981	0.981
.06	.981	.981	.980	.980	.979	.979	.978	.978	.977	.977
.07	.978	.977	.977	.976	.976	.975	.975	.974	.974	.973
.08	.975	.974	.974	.973	.972	.972	.971	.970	.970	.969
.09	.972	.971	.970	.970	.969	.968	.967	.967	.966	.965
0.10	0.968	0.968	0.967	0.966	0.965	0.965	0.964	0.963	0.962	0.962
.11	.965	.964	.964	.963	.962	.961	.960	.959	.959	.958
.12	.962	.961	.960	.959	.958	.958	.957	.956	.955	.954
.13	.959	.958	.957	.956	.955	.954	.953	.952	.951	.950
.14	.956	.955	.954	.953	.952	.950	.949	.948	.947	.946
0.15	0.953	0.952	0.950	0.949	0.948	0.947	0.946	0.945	0.943	0.942
.16	.950	.948	.947	.946	.945	.943	.942	.941	.940	.938
.17	.946	.945	.944	.942	.941	.940	.939	.937	.936	.935
.18	.943	.942	.940	.939	.938	.936	.935	.934	.932	.931
.19	.940	.939	.937	.936	.934	.933	.931	.930	.928	.927
0.20	0.937	0.935	0.934	0.932	0.931	0.929	0.928	0.926	0.925	0.923
.21	.934	.932	.931	.929	.927	.926	.924	.922	.921	.919
.22	.931	.929	.927	.926	.924	.922	.920	.919	.917	.915
.23	.927	.926	.924	.922	.920	.919	.917	.915	.913	.912
.24	.924	.922	.921	.919	.917	.915	.913	.911	.910	.908
0.25	0.921	0.919	0.917	0.915	0.913	0.912	0.910	0.908	0.906	0.904
.26	.918	.916	.914	.912	.910	.908	.906	.904	.902	.900
.27	.915	.913	.911	.909	.907	.904	.902	.900	.898	.896
.28	.912	.910	.907	.905	.903	.901	.899	.897	.894	.892
.29	.909	.906	.904	.902	.900	.897	.895	.893	.891	.888
0.30	0.905	0.903	0.901	0.898	0.896	0.894	0.892	0.889	0.887	0.885
.31	.902	.900	.897	.895	.893	.890	.888	.886	.883	.881
.32	.899	.897	.894	.892	.889	.887	.884	.882	.879	.877
.33	.896	.893	.891	.888	.886	.883	.881	.878	.876	.873
.34	.893	.890	.888	.885	.882	.880	.877	.874	.872	.869
0.35	0.890	0.887	0.884	0.882	0.879	0.876	0.873	0.871	0.868	0.865
.36	.886	.884	.881	.878	.875	.873	.870	.867	.864	.862
.37	.883	.880	.878	.875	.872	.869	.866	.863	.861	.858
.38	.880	.877	.874	.871	.868	.866	.863	.860	.857	.854
.39	.877	.874	.871	.868	.865	.862	.859	.856	.853	.850
0.40	0.874	0.871	0.868	0.865	0.862	0.858	0.855	0.852	0.849	0.846

Table 4—Values of Y for air ($k = 1.4$)

$\frac{p}{P_1}$	N									
	0.41	0.42	0.43	0.44	0.45	0.46	0.47	0.48	0.49	0.50
0.00	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000
.01	.997	.997	.997	.997	.997	.997	.997	.997	.996	.996
.02	.994	.994	.994	.994	.994	.993	.993	.993	.993	.993
.03	.991	.991	.991	.991	.990	.990	.990	.990	.990	.989
.04	.988	.988	.988	.987	.987	.987	.987	.986	.986	.986
0.05	0.985	0.985	0.985	0.984	0.984	0.984	0.983	0.983	0.982	0.982
.06	.982	.982	.982	.981	.981	.980	.980	.979	.979	.979
.07	.980	.979	.978	.978	.978	.977	.976	.976	.976	.975
.08	.977	.976	.975	.975	.974	.974	.973	.973	.972	.971
.09	.974	.973	.972	.972	.971	.970	.970	.969	.968	.968
0.10	0.971	0.970	0.969	0.969	0.968	0.967	0.966	0.966	0.965	0.964
.11	.968	.967	.966	.965	.965	.964	.963	.962	.962	.961
.12	.965	.964	.963	.962	.961	.961	.960	.959	.958	.957
.13	.962	.961	.960	.959	.958	.957	.956	.955	.954	.954
.14	.959	.958	.957	.956	.955	.954	.953	.952	.951	.950
0.15	0.956	0.955	0.954	0.953	0.952	0.951	0.950	0.949	0.948	0.946
.16	.953	.952	.951	.950	.949	.947	.946	.945	.944	.943
.17	.950	.949	.948	.947	.945	.944	.943	.942	.940	.939
.18	.947	.946	.945	.943	.942	.941	.940	.938	.937	.936
.19	.944	.943	.942	.940	.939	.938	.936	.935	.934	.932
0.20	0.941	0.940	0.939	0.937	0.936	0.934	0.933	0.931	0.930	0.929
.21	.938	.937	.936	.934	.932	.931	.930	.928	.926	.925
.22	.936	.934	.932	.931	.929	.928	.926	.925	.923	.921
.23	.933	.931	.929	.928	.926	.924	.923	.921	.920	.918
.24	.930	.928	.926	.925	.923	.921	.919	.918	.916	.914
0.25	0.927	0.925	0.923	0.921	0.920	0.918	0.916	0.914	0.912	0.911
.26	.924	.922	.920	.918	.916	.915	.913	.911	.909	.907
.27	.921	.919	.917	.915	.913	.911	.909	.907	.906	.904
.28	.918	.916	.914	.912	.910	.908	.906	.904	.902	.900
.29	.915	.913	.911	.909	.907	.905	.903	.901	.898	.896
0.30	0.912	0.910	0.908	0.906	0.904	0.901	0.899	0.897	0.895	0.893
.31	.909	.907	.905	.903	.900	.898	.896	.894	.892	.889
.32	.906	.904	.902	.899	.897	.895	.893	.890	.888	.886
.33	.903	.901	.899	.896	.894	.892	.889	.887	.884	.882
.34	.900	.898	.896	.893	.891	.888	.886	.883	.881	.879
0.35	0.898	0.895	0.892	0.890	0.888	0.885	0.882	0.880	0.878	0.875
.36	.895	.892	.889	.887	.884	.882	.879	.877	.874	.871
.37	.892	.889	.886	.884	.881	.878	.876	.873	.870	.868
.38	.889	.886	.883	.881	.878	.875	.872	.870	.867	.864
.39	.886	.883	.880	.877	.875	.872	.869	.866	.864	.861
0.40	0.883	0.880	0.877	0.874	0.871	0.869	0.866	0.863	0.860	0.857

the orifice. On the other hand, when using equations 1, 2, and 3 to compute the amount of hot water flowing through the orifice, it would be necessary to use the actual density of the water flowing through the orifice, or 56.7 lb per cu ft.

If the flow of steam—or any other condensable vapor — whose condensing temperature is above the room temperature were being measured, obviously steam would condense inside the manometer and the space above the mercury would soon be filled with water. If the manometer were installed as in Fig. 4, as the mercury level changed water would be forced in and out of the piping connections—which would give erratic results.

Density Values with Steam and Condensable Vapors

To obtain reliable results, manometers for measuring steam and condensable vapor flow are installed with a pair of liquid level chambers like "A" in Fig. 5. By installing these chambers at exactly the same level, the manometer connections will always be filled with water up to the level indicated by the dashed line of Fig. 5. In this way, even though water is forced in and out of the connections with every change in the height of the mercury column, the head of liquid is never changed because the diameters of the chambers "A" are large compared to the diameter of the manometer tubing. As a result, the small amount of liquid moved by the mercury has only a negligible effect on the level of the liquid in the chambers "A."

Because the manometer is filled with water when measuring steam, it is obvious that the density of the liquid in the manometer is many times the density of the steam flowing through the orifice. For example, if the pressure of the steam ahead of the orifice is 125 lb ga, the density of the steam will be 0.308 lb per cu ft, whereas the density of the water above the mercury in the manometer will be 62.3 lb per cu ft. To determine the pressure difference across the orifice, the value of 62.3 should be substituted for d_L in equation 8. On the other hand, when calculating the weight of steam flowing through the orifice, the value of 0.308 lb per cu ft should be substituted for d in equations 5 and 6.

In selecting an orifice for the conditions of the preceding paragraph, the value of 62.3 would be substituted in [8a] for d_L in determining the pressure difference across the orifice for the selected rise h of the mercury column. But when computing Z for selecting the orifice, the value of 0.308 would be substituted for d in equation 7. When the density of the liquid above the mercury in the manometer differs from the density of the liquid flowing through the orifice, it is necessary to exercise care in using the correct density values in equation 8 and in equation 1 or 5.

Density Values When There Is No Condensation

When measuring the flow of a compressed gas, where there is no condensation of liquid from the gas to fill up the spaces in the manometer above the mercury, equations 8 and 8a can be simplified. In this case the spaces above the mercury are filled with the same compressed gas. However, the density of all commonly used gases is negligible compared to the very great density of the mercury. Consequently, if d_L is negligibly small compared to d_H, and using the value of 845.6 as the density of mercury, equations 8 and 8a may be reduced to the following form:

$$p = 0.489\ h \quad \text{.....[9]}$$

$$h = 2.04\ p \quad \text{.....[9a]}$$

It is possible to use equation 8 or 9 to select the height of the manometer. Obviously, if a given mercury height is assumed, the pressure difference across the orifice can be computed by means of either equation 8 or 9. Knowing the pressure difference, either equation 4 or equation 7 can be used to select an orifice for the pressure difference determined from the given manometer length.

Effect of Studs and Joists on HEAT FLOW Through Frame Construction

Paul D. Close Tells When to Allow for the Effect of Framing Members in Calculating Heat Loss of Wood Buildings

Often Neglected

The effect of studs, joists, and other framing on heat flow through walls and ceilings is often neglected in calculating the heat loss coefficients from which heat loads are figured. However, this factor may often have a decided effect and frequently should be allowed for. With the greater use of wood for construction of buildings, due to wartime restrictions, the matter is of increased importance.

Mr. Close, technical secretary of the Insulation Board Institute, and a well-known writer on insulation problems, presents tables and charts here for determining how the framing affects the heat loss coefficients.

THE EFFECT of studs, joists, and other framing on the heat flow through walls and ceilings is often neglected in calculating heat loss coefficients. However, the rate of heat loss through the thickness of wood at the studs and other framing members is considerably less than that through the air spaces between the studs, and this may have a decided effect on the value of the heat loss coefficient. The matter becomes of greater importance with the increased use of wood for building construction.

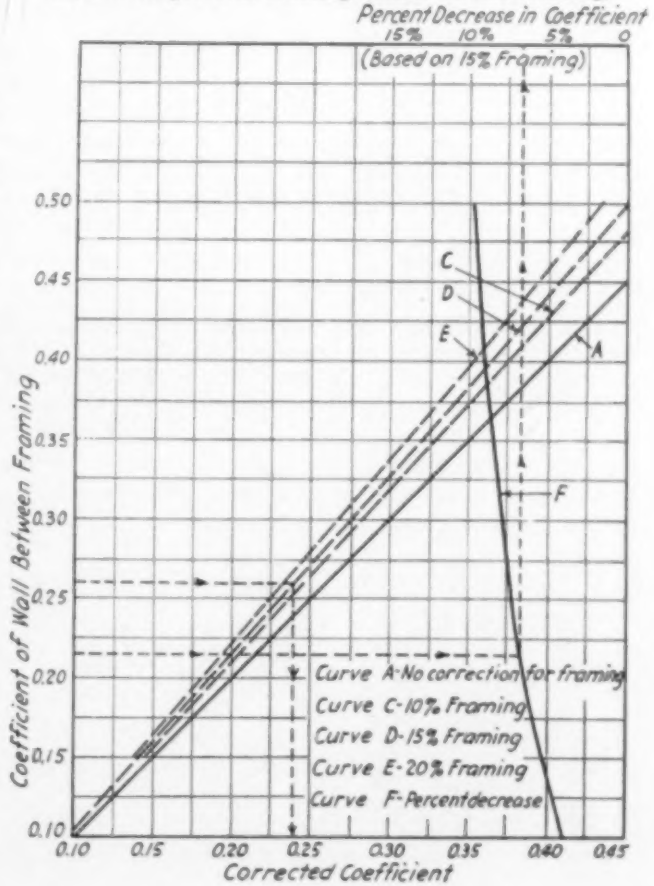
The studs alone (based on 16 in. centers) comprise approximately 10 per cent of the net wall area, exclusive of doors and windows. To this should be added the door and window framing, the plate and sill and any headers or fire blocking. These may increase the percentage of wood by at least another 10 per cent in many cases, so that the studs and other framing may comprise as much as 20 per cent of the net wall area, after deducting the door and window openings. A conservative average is 15 per cent.

The effect of the framing on heat loss coefficients of various values is shown by Table 1, which gives the corrected heat loss coefficients of hollow frame walls for various percentages of framing. The figures in column A are the usual coefficients for which no allowance for framing has been made. The figures in column B are the corresponding coefficients of the walls through the 3⅝ in. thick wood framing, and the figures in columns C, D, and E are the corrected coefficients based on 10, 15, and 20 per cent wood framing. For example, a frame wall having a value of 0.25, neglecting the framing, would have a corrected coefficient of 0.232 based on 15 per cent wood framing. Thus, the studs decrease the rate of heat flow through the wall to the extent of 7.2 per cent in this case, as shown in column F.

Fig. 1 shows graphically the effect of the wood framing on the heat loss coefficients of frame walls of various values based on the figures in columns A, C, D, and E of Table 1. Curve A is for frame walls for which no correction for framing has been made, whereas curves C, D and E are for the corrected coefficients for 10, 15, and 20 per cent wood framing, respectively. The corrected coefficients for frame walls ranging from 0.10 to 0.45 may readily be determined by means of these curves. The majority of hollow frame walls range between 0.15 and 0.30.

A wall having 0.983 in. of insulation (with a conductivity of

Fig. 1—Heat flow coefficients for frame walls with air spaces, showing coefficients for which no correction for framing has been made and corrected coefficients for 10, 15, and 20 per cent framing (based on 2x4 framing)



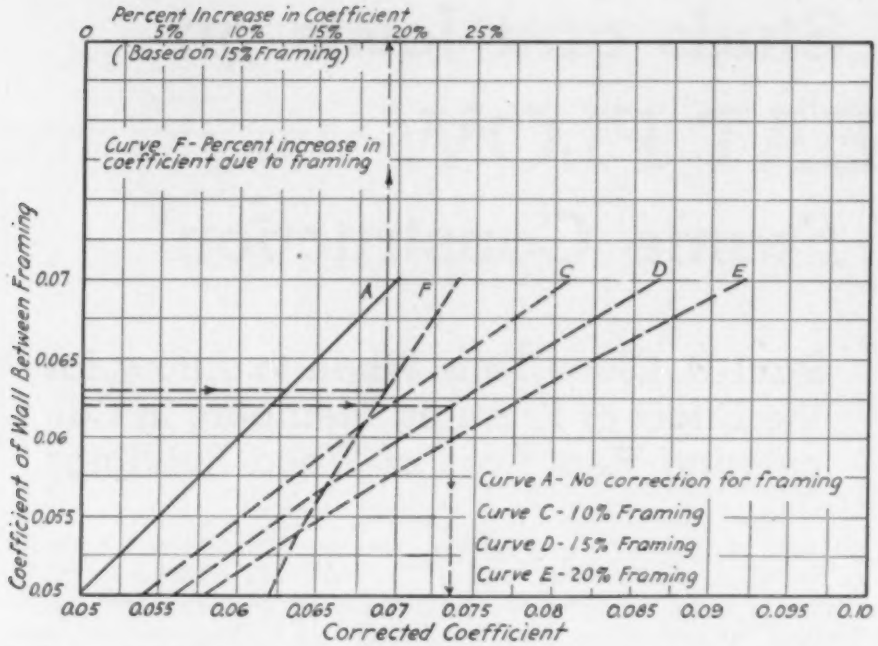


Fig. 2—Heat flow coefficients for frame walls containing 3⅝ in. fill insulation, showing coefficients for which no correction for framing has been made and corrected coefficients for 10, 15, and 20 per cent framing (based on 2x4 framing)

Table 1—Corrected heat loss coefficients (*U*) of frame walls with conventional air space between studs for various percentages of framing. Coefficients are expressed in Btu per hr per sq ft per F temperature difference

Coefficient of wall between framing[a]	Corresponding coefficient of wall at framing[b]	Corrected coefficients[c]			Per cent decrease in coefficient based on 15% framing
		10% Framing	15% Framing	20% Framing	
A	B	C	D	E	F
0.10	0.073	0.097	0.096	0.095	4
0.15	0.097	0.145	0.142	0.139	5⅓
0.20	0.116	0.192	0.187	0.183	6.5
0.25	0.131	0.238	0.232	0.226	7.2
0.30	0.144	0.284	0.277	0.269	7.8
0.35	0.154	0.33	0.321	0.311	8.4
0.40	0.163	0.376	0.364	0.353	9
0.50	0.177	0.468	0.452	0.435	9.7

[a] No allowance for framing.

[b] The resistance of an air space is 0.91. The resistance of the 3⅝ in. thickness of wood at the studs is 3.625 × 1.25, or 4.53. The difference, or 4.53 — 0.91 = 3.62, represents the difference in the resistances upon which the coefficients in column B are based. Example: If the wall coefficient between framing (column A) is 0.20, the overall resistance will be 5.00 and the resistance of the corresponding coefficient in column B will be 5.00 + 3.62, or 8.62 and the corresponding coefficient in Column B will therefore be 1/8.62 or 0.116, as indicated.

[c] Corrected or weighted values of wall coefficients in column A for percentages of framing indicated.

Table 2—Corrected heat loss coefficients (*U*) of frame walls containing 3⅝ in. of fill insulation for various percentages of framing. Coefficients are expressed in Btu per hr per sq ft per F temperature difference

Coefficient of wall between framing[a]	Corresponding coefficient of wall at framing[b]	Corrected coefficients[c]			Per cent increase in coefficient based on 15% framing
		10% Framing	15% Framing	20% Framing	
A	B	C	D	E	F
0.05	0.09	0.054	0.056	0.058	12
0.055	0.108	0.0603	0.063	0.0656	14.5
0.06	0.129	0.0668	0.0704	0.0738	17.3
0.065	0.154	0.0739	0.0784	0.0828	20.6
0.07	0.181	0.0811	0.0867	0.0922	23.9

[a] Assumed conductivity (*k*) = 0.27.

[b] The resistance of a 3⅝ in. thickness of insulation having a conductivity of 0.27 is 13.43. The resistance of the 3⅝ in. thickness of wood at the studs is 4.53. The difference of 13.43 — 4.53 = 8.90, represents the difference in the resistances upon which the coefficients in column B are based. Example: If the coefficient of the wall between framing is 0.06, the overall resistance will be 16.67 and the resistance of the corresponding coefficient in column B will be 16.67 — 8.90, or 7.77 and the corresponding coefficient in column B will therefore be 1/7.77 or 0.129 as indicated.

[c] Corrected or weighted values of wall coefficients in column A for percentages of framing indicated.

0.27) between the studs and in contact with the sheathing, will have the same value through or between the studs. In other words, the 0.983 in. of insulation (or say 1 in.) of this conductivity, plus the air space, has approximately the same resistance (4.53) as the 3⅝ in. of wood at the studs which, of course, means that the framing does not change the value of frame walls with about 1 in. of blanket insulation (having a conductivity of 0.27) in contact with the sheathing.

If the air space is filled with an insulating material, the effect of the studs and other framing members is to increase the average rate of heat flow. Table 2 gives corrected coefficients for frame walls of various values containing 3⅝ in. of insulation having a conductivity of 0.27, between the studs. For example, a frame wall containing 3⅝ in. of insulation and having a value of 0.065 between the framing, would have an average coefficient of 0.0784 based on 15 per cent wood framing. Thus the framing increases the rate of heat flow through the wall to the extent of 20.6 per cent in this case, as shown in column F. The curves of Fig. 2 show the relationship graphically.

The foregoing analysis is based on the assumption of straight line or parallel heat flow through the studs and insulating material between the studs. Actually the heat flow may not be in straight lines but rather may travel along radial or curved lines, particularly through the studs in the case of hollow frame walls. However, for the purpose of this analysis, the assumption of straight line heat flow would appear to be justified and experimental work at the University of Minnesota in general substantiates the corrections indicated.

Since the majority of hollow frame walls range in value from 0.15 to 0.30, the correction for these walls (based on 15 per cent framing) will range between about 5 to about 8 per cent (Fig. 1). However, this correction is compara-

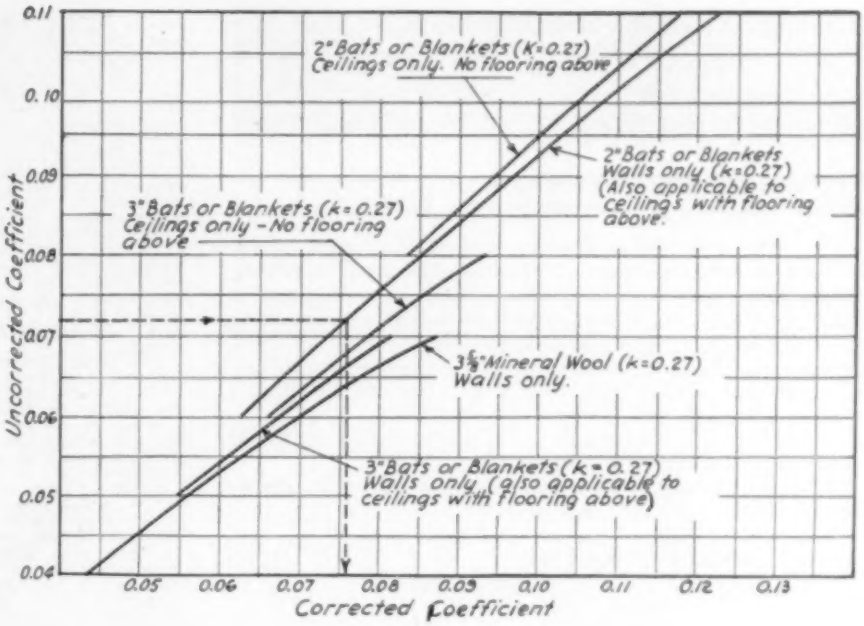


Fig. 3—Curves for correcting frame wall and ceiling heat flow coefficients, the coefficients being based on 2x4 framing comprising 15 per cent of the net area and being expressed in Btu per hr per sq ft per F temperature difference

tively small and may be neglected since to do so would be on the side of safety. On the other hand, the correction for walls containing more than 1 in. of insulation between the studs may be of somewhat greater magnitude and is in the opposite direction and particularly for the latter reason this correction should be made.

It is apparent that the correction to be made will depend upon many factors such as the initial overall coefficient (without the correction), the thickness and conductivity of the insulation between the framing, the percentage and thickness of framing, and whether the construction is a wall, roof or ceiling and, in the latter case, whether there is flooring above the ceiling. A few typical correction curves for the conditions indicated are given in Fig. 3. It will be noted that these are based on 2x4 framing comprising 15 per cent of the net surface area. While 2x4 framing on 16 in. centers is common practice for frame walls, the ceiling or roof construction is more often of 2x6 framing and in some cases, 24 in. centers are used.

Polarized Light Used to Study Fluid Flow

THE DIVERSE responses of a flowing fluid to variously shaped obstacles such as a ship hull or a heating pipe form a fascinating study, but not a very exact one unless the directions of flow can be made visible. A new method of doing this, developed during recent years at the Massachusetts Institute of Technology, promises a real advance in this branch of hydrodynamics. The method is analogous to that wherein engineers use polarized light, produced with optical equipment similar to that in "Polaroid" non-glare sun glasses, to render visible the strains in plastic models of solid structures, such as gears. When stressed, the plastic model deforms slightly, and in so doing, bends and twists the polarized light passing through it so that bands and splotches of color show up at the points of strain. In the analysis of fluid flow a suspension of bentonite (a clay found abundantly in the west) in the fluid serves to modify the polarized light shining through the transparent walls of the experimental channel, just as the plastic modifies light in analysis of strains in solids.

The bentonite particles consist of platelets so small that there is no tendency to settle out of the suspension and so light that they move exactly where the fluid takes them, showing substantially no inertia of their own. These physical factors, as well as its optical properties, make bentonite superior to other substances used to follow fluid flow, such as ink streams, smoke trails in gases, or fine bubbles; for these latter materials cannot follow the paths of fine eddy motion encountered when streamline flow is broken up. The bentonite for the first time permits quantitative measurement of velocity change and other factors *within* the field.

Solid plastic models examined with polarized light show infinitely varied colored patterns when subjected to pressure or tension. A line of a given color connects points where the strain is equal; from this the analyst can determine where the strains are concentrated and the model can be redesigned to put strength where it is needed and eliminate it where it is not needed. Similarly, in analysis of fluids the bentonite so modifies the light passing through the stream that colored bands or "fringes" show up, connecting points where a particular rate of change in the speed of the fluid prevails. Use of improved photographic techniques, including high speed photography, has enabled observation of highly turbulent as well as more nearly streamline flow by this method.

The method can be used either qualitatively to observe how a moving or stationary object of particular shape affects the flow, or quantitatively to calculate necessary engineering data. Analysis of fluid flow is important not only in such obvious applications as design of ship hulls and bridge piers but also in many chemical engineering problems such as the distribution of fluids in a reaction vessel. It is even possible by polarization analysis of fluid flow to calculate the rate at which heat will be transferred from a solid to a liquid. — Industrial Bulletin of Arthur D. Little, Inc.

• WPB . . . OPA . . . PAW . . . Etc. •

Heating System Controls and Other Equipment Exempted from L-79

The War Production Board's general limitation order L-79 on metal plumbing and heating equipment, requiring orders rated A-10 or higher for delivery or acceptance of delivery of such equipment, was amended September 13 to exempt heating system controls, as specified in schedule A of the order, from its provisions. The schedule of exempted equipment also includes warm air heating air filters, various valves and traps, heating pumps, etc.

Following is the schedule of heating system controls as given in the amended order:

Automatic temperature control equipment used in steam, warm air and hot water heating systems.

Thermostats (indoor and outdoor types).

Draft and damper regulators.

Draft adjustors, barometric and mechanical.

Motor-operated valves (steam and hot water).

Pressure reducing valves (steam heating system).

Induced and forced draft blowers.

Draft gages.

Flue gas thermometers.

Thermometers (space heating and domestic hot water type only).

Thermostatic valves, capillary tube and self contained types to control the flow of steam or hot water.

Air vent valves and eliminators.

Thermostatic traps, radiator and drip.

Radiator valves having cast iron bodies only.

Thermostatic valves and checks.

Orifices and other proportioning devices.

Low pressure heating pumps, single only (vacuum, condensation and hot water circulating).

Hot water flow checks and balancing elbows.

Time switches.

Air filters (warm air heating).

Zone (single) temperature control systems.

Heating system temperature control panelboards.

Flue gas analyzers and CO_2 meters.

P-126 on Emergency Servicing Of Air Conditioning Revised

The War Production Board issued September 15 a thoroughly revised amended preference rating order P-126 on material for emergency servicing of industrial and commercial refrigerating and air conditioning systems. Following are parts of the order quoted in full, the omissions being noted in each instance:

§ 1226.22 *Preference Rating Order P-126*—(a) *General purpose and effect.* This order gives preference ratings to help service agencies (as defined herein) get parts and materials for the emergency maintenance and repair of industrial and commercial refrigerating and air conditioning systems (as defined herein). No such service agency shall obtain any parts and materials for the emergency maintenance and repair of systems under CMP Regulations 5 or 5A except as specified in this order. However, delivery may be made and accepted on any delivery order placed pursuant to CMP Regulations 5 or 5A before October 15, 1943. Nothing in this order shall prevent any person other than a service agency from using CMP Regulations 5 or 5A.

[*Note*—The order then defines "system," "refrigerant," "parts and materials," "emergency maintenance," "emergency repair," "service agency," and "largest inventory allowed."]

(c) *Assignment of preference ratings.* The following preference ratings and allotment symbols are assigned to orders placed by any service agency for delivery of parts and materials to it:

Class I: (1) AA-1—MRO, for parts and materials needed by the service agency in the emergency maintenance or emergency repair of systems used in industrial food manufacturing, processing, packaging, preservation, storage, or transportation, or in the conduct of other activities, or in the manufacture of products, or in the rendering of services, listed in Schedule I of CMP Regulations 5 and 5A. (But this rating is not assigned to orders for parts and materials to be used in systems of restaurants, hotels, or retail stores; or in systems of soft drink or malt beverage processors or dispensers; or in milk cooling systems on farms.)

Class II: (2) AA-2—MRO, for parts and materials (i) needed by the service agency in the emergency maintenance or emergency repair of systems used in restaurants, hotels, or retail stores (except air conditioning systems used in restaurants, hotels, or retail stores); or of milk cooling systems on farms; or of systems used in the manufacture of products, or in the conduct of activities, or in the rendering of services, listed in Schedule II of CMP Regulations 5 and 5A; or (ii) needed by the service agency in building up its inventory to the largest inventory allowed.

Class III: (3) AA-5—MRO, for parts and materials needed by the service agency in the emergency maintenance or emergency repair of systems (except air conditioning systems) used in the manufacture of products, or in the conduct of activities, or in the rendering of services, which are not listed in Schedule I or II of CMP Regulations 5 or 5A or in Class II (above).

(d) *Restrictions on application of preference ratings.* (1) Except to build up its inventory to the largest inventory allowed as provided in paragraph (c) (2) (Class II), no service agency shall apply a rating to an order for parts and materials unless it has actually undertaken a job for which those parts and materials are needed. When a service agency, however, has the right to apply a Class I or II rating to an order for parts and materials then it may take them from its inventory and apply the rating to get the same kind, quality, and quantity of parts and materials to replace them.

(2) No service agency shall apply any ratings assigned by this order:

(i) To get parts and materials which will increase its inventory above the largest inventory allowed, or

(ii) To get parts and materials to be used in a new system, or to expand an existing system, or

(iii) To get parts to improve any system or part of a system by replacing parts and materials which are still usable with parts and materials of a larger capacity, or of a better kind, quality or design, or

(iv) To get parts and materials to recondition any system which is not already installed.

(e) *Restrictions on use of inventory.* No service agency shall take parts and materials from its inventory for use in systems in Class III. The purpose of this restriction is to reserve parts and materials in inventory for the emergency repair and maintenance of the more essential systems in Classes I and II. When a service agency has actually undertaken a job for the emergency maintenance or emergency repair of a system in Class III and needs parts and materials for that system, it must place an order for the parts and materials with its supplier. It may not apply a rating higher than the Class III rating to the order.

(f) *Controlled materials.* A service agency may use the CMP allotment symbol MRO to place an authorized controlled material order for controlled materials (steel sheets, copper wire, copper tubing, etc.) for the same purposes for which it can use the Class I or II rating. It cannot, however, use the CMP allotment symbol MRO to get aluminum. Also, the service agency cannot buy controlled materials for any use to which a Class III rating is given unless it gets special permission. The next paragraph tells how to get this special permission.

(g) *Special permission.* Any service agency needing controlled materials, except aluminum, which it cannot get under this order, may apply at the nearest office of the War Production Board on Form WPB-541 (formerly Form PD-1A) for the right to use the MRO symbol to get controlled materials, except aluminum. Also any service agency needing parts and materials which cannot get them with the ratings assigned in this order, may apply to the nearest office of the War Production Board for a higher rating by using the same form. Any service agency needing aluminum may obtain it in the manner provided in CMP Regulation 5, paragraph (g-1); or CMP Regulation 5A, paragraph (h) (2).

(h) *How a service agency places purchase orders for parts and materials*—(1) *Application of ratings.* The service agency using the ratings given by this order shall endorse on the original and all copies of each purchase order, or contract, for parts and materials placed by it which are to be rated under this order, a certification in substantially the following form (with the blank spaces filled in) signed in handwriting, or as provided in Priorities Regulation 7, by each agency or its agent or official duly authorized for this purpose:

Preference Rating AA.....MRO

As an authorized official of the purchaser, I certify, subject to criminal penalties for misrepresentation, that the use of any preference rating or allotment number or symbol which is placed on this order is authorized and that the items ordered will be received and used or disposed of in compliance with all applicable regulations and orders of the War Production Board, including Order P-126.

.....
(Name)

By.....
(Authorized Official)

(2) *Authorized controlled material orders.* A service agency ordering controlled materials for a Class I or Class II purpose (or any other purpose for which special permission has been given under paragraph (g)) shall endorse the certification in the previous paragraph on the original and all copies of each purchase order, substituting the phrase "CMP Allotment Symbol MRO" for the phrase "Preference Rating AA.....MRO". A purchase order bearing such an endorsement shall constitute an Authorized Controlled Material order for the purpose of all CMP Regulations.

Control of the Air in Industry Is Helping to Win the Battle of Production

(i) *Required disposal of replaced parts.* (1) No service agency shall deliver any new part to a person who owns or uses the system in which it is to be installed unless the delivery is made upon condition that any replaced used part made of metal will be disposed of in either of two ways: through regular scrap channels within thirty (30) days after the installation of the new part, or by delivery to the service agency.

The service agency shall take all the used parts delivered to it during any calendar quarter and shall do one of three things. The service agency shall repair and place the used part in its inventory, or return the used part to its supplier of new parts, or dispose of the used part through regular scrap channels within thirty (30) days after the end of the calendar quarter. No block

tin pipe, however, shall be replaced in a system unless an equal quantity of block tin pipe is returned to fabricator.

(2) These requirements for the disposal of replaced parts shall not apply:

(i) Where parts are delivered for installation in any system located outside of the United States at the time of such delivery, or

(ii) Where the system is being used directly by the Army, Navy Maritime Commission, or War Shipping Administration, or

(iii) Where the system is owned by any Federal, State or local Government agency, bureau, department or political subdivision which is prohibited by law from disposing of replaced parts in this way.

(j) *Construction.* When emergency maintenance or emergency repair involves construction, authorization to construct must be obtained to the extent required by Conservation Order L-41 or by any other applicable order or regulation of the War Production Board.

[*Note*—The order concludes with sections on miscellaneous provisions, records, reports, appeals, communications, violations, and revocation (of counterparts of P-126) and its effects.]

L-38 Interpretation Allows Purchase Of Slightly Different Type of System

The War Production Board issued September 9 interpretation 2 to general limitation order L-38 (industrial and commercial refrigerating and air conditioning machinery and equipment), covering the question of a purchaser acquiring a system of a slightly different type or size from that applied for, in order to obtain a system which uses some other refrigerant but has the same refrigerating capacity.

According to the interpretation, "where orders have been authorized on forms WPB-2448 and WPB-2449 (formerly PD-830 and PD-831) upon the condition that a specified product, such as dichlorodifluoromethane (sometimes also called 'F-12' or 'Freon 12') shall not be used as the refrigerant in the system covered by the authorization, the question has arisen as to whether the purchaser may acquire a system of a slightly different size or type from that applied for, in order to obtain a system which uses some other refrigerant, but has the same refrigerating capacity as that applied for.

"In such a case, the purchaser is permitted to purchase a system of substantially the same refrigerating capacity, even though it uses a different type of expansion valve or other parts, or contains a slightly larger compressor, condenser, motor or other parts, in order to obtain the same refrigerating capacity which has been authorized for installation. For example, the use of a machine having a motor of the standard size nearest to that applied for would be permissible, if necessary to obtain the authorized refrigerating capacity. Any incidental additional cost resulting solely from such a change to another refrigerant would also be permissible.

"The fact that the applicant states the name of the probable supplier, or the model number, does not require him to purchase from the supplier named, or to get the model mentioned, as long as he gets a machine of substantially the same capacity and designed to perform the same function."

Repair and Maintenance Services for Stokers

Repair and maintenance services for coal stokers having a maximum capacity of under 1200 lb per hr of coal were transferred last month from the general maximum price regulation and placed under coverage of the services regulation by the Office of Price Administration.

The action places services for this type of coal stokers under the same measure covering services for oil burners burning No. 5 oil or lighter, since both automatic heating devices use, in the main, the same type of controls and are serviced by the same class of mechanics.

The main reason for the action was administrative, since it will permit OPA to regulate the suppliers of the services for both of these types of heating devices under the same regulation. The action should have no effect on present prices for the services, which are at the level of those permitted under regulation 165 (services), since both regulations are based on March, 1942, levels.

The transfer of control was accomplished by amendment No. 29 to regulation 165, which became effective September 21.

• WPB . . . OPA . . . PAW . . . Etc. •

Conservation Order M-28 On Refrigerants Amended Again

Changes Benefit Users of Industrial Air Conditioning

The vital importance of chlorinated hydrocarbon refrigerants ("Freon") in the production of certain war materials, as an insecticide for malaria control, and for other essential military and civilian uses has made it necessary for the War Production Board to control them in some respects. However, their uses for certain refrigeration and air conditioning installations directly connected with the war program have been exempted from the necessity of obtaining specific WPB authorization for individual deliveries.

Conservation order M-28, as amended September 7 by WPB, required certification of purchase orders of "Freon" by users to the effect that it is needed for immediate use. Certification formerly stated that the refrigerant would be needed during the following 30 days. This, in effect, means that "Freon" may only be purchased in the case of actual breakdown and not for "standby" charges except as designated.

The amended order also requires purchasers and users of "Freon 12" (dichlorodifluoromethane) for ship building operations to make separate authorization application giving specific data on its proposed use.

However, "Freon 12" may be obtained for specified systems and uses enumerated in list C of the amended order through purchase order certification without WPB authorization. Among the 27 types of uses included in list C are:

Air conditioning equipment in crane cabs; air conditioning to maintain prescribed conditions in laboratories conducting tests on parts or instruments for aircraft, combat tanks, ships, radio equipment; air conditioning for temperature and humidity control in the production of gyroscopic instruments and compasses; air conditioning for the production and storage of penicillin and blood serum; refrigeration for cooling X-ray apparatus used in analyzing castings in aircraft and other combat vehicles; refrigeration for low temperature chambers designed to duplicate substratospheric conditions for testing instruments, flying clothes, personnel and equipment; and others.

Deliveries of "Freon 11" (monofluorotrichloromethane) have been exempted from specific authorization except for list B installations. This change has been made because "Freon 11" is a byproduct of "Freon 12" and its production does not lessen the output of F-12. There is sufficient supply of "Freon 11" to meet requirements, according to the WPB.

The following questions and answers pertaining to conservation order M-28 were issued September 9 by WPB's general industrial equipment division, in response to a request made by industry members at the recent joint meeting of the general refrigeration and air conditioning industry advisory committee and the industrial refrigeration industry advisory committee.

1. Q. What procedure should be followed by refrigeration and air conditioning equipment manufacturers to obtain additional quantities of chlorinated hydrocarbon refrigerants ("Freon") for uses designated in M-28 as Class I: Army, for new and existing systems; Class II: Navy, for new and existing systems; Class III (a) and (b) Maritime Commission or War Shipping Administration for new systems at factories of equipment manufacturers, and new systems in the field?

A. Additional quantities of "Freon" for Classes I and II should be requested from the Army and Navy respectively. "Freon" for Class III (a) and (b) uses should be requested from WPB's general industrial equipment division.

2. Q. When "Freon" for Classes I, II, and III (a) and (b) are not available—that is, when applications are denied—to whom should the manufacturer apply for authorization to make a change in the refrigerant?

A. A request for a change in refrigerant should be directed to the government agency from which the manufacturer received his contract.

3. Q. If the contracting officer of the government agency refuses to grant additional quantities of "Freon" or to authorize

• WPB . . . OPA . . . PAW . . . Etc. •

a change in refrigerant, what recourse is available to the industry on prime contracts and subcontracts?

A. This is a matter for settlement between the contractor and the government agency, just as in any other case where a contract cannot be fulfilled exactly in accordance with its terms because of a shortage of material or other difficulty. It is expected that the agency will settle the matter on the basis of the supply of "Freon" allotted to it.

The text of the M-28 order as amended August 7 was published in the September issue, starting on p. 168 in the back section. Following is the text of the order as amended on September 7:

PART 1226—GENERAL INDUSTRIAL EQUIPMENT[1]

[Conservation Order M-28, as Amended September 7, 1943]

CHLORINATED HYDROCARBON REFRIGERANTS

The fulfillment of requirements for the defense of the United States has created a shortage in the supply of chlorinated hydrocarbon refrigerants for defense, for private account and for export; and the following order is deemed necessary and appropriate in the public interest and to promote the national defense.

§ 1226.27[1] *Conservation Order M-28*—(a) *Definitions.* For the purpose of this order:

(1) "Chlorinated hydrocarbon refrigerants" means trichloromonofluoromethane, dichlorodifluoromethane, dichloromonofluoromethane, trichlorotrifluoroethane, and dichlorotetrafluoroethane.

(2) "Person" means any individual, partnership, association, business trust, corporation, governmental corporation or agency or any organized group of persons whether incorporated or not.

(3) "Producer" means any person engaged in the production of chlorinated hydrocarbon refrigerants.

(4) "Contract agent" means any person engaged in the business of accepting orders for chlorinated hydrocarbon refrigerants on behalf of and as agent for a producer.

(5) "Supplier" means any person engaged in the business of distributing chlorinated hydrocarbon refrigerants to persons using the same for installation in a refrigerating or air conditioning "system". The term shall include an equipment manufacturer to the exteht that he engages in the sale of such refrigerants to distributors or dealers handling "systems". "System" means any "system" as defined in General Limitation Order L-38.

(6) "Equipment manufacturer" means any person who uses chlorinated hydrocarbon refrigerants for charging new refrigerating or air conditioning systems manufactured by him.

(7) "Insecticide manufacturer" means any person who uses chlorinated hydrocarbon refrigerants in the production of insecticides.

(8) "User" means any person who installs chlorinated hydrocarbon refrigerants in a refrigerating or air conditioning system, other than an equipment manufacturer.

(9) "Comfort cooling system" means any air conditioning system of a type described on List A, made a part of this order.

(b) *Classification of uses of chlorinated hydrocarbon refrigerants.* The uses of chlorinated hydrocarbon refrigerants are hereby classified as follows:

Class I: Army, for use in new or existing refrigeration and air conditioning systems.

Class II: Navy, for use in new or existing refrigeration and air conditioning systems.

Class III: (a) Maritime Commission or War Shipping Administration, for charging new refrigeration or air conditioning systems at factories of equipment manufacturers.

(b) Maritime Commission or War Shipping Administration, for charging new refrigeration or air conditioning systems in the field.

(c) Maritime Commission or War Shipping Administration, for maintenance and repair of systems already installed.

Class IV: (a) For maintenance of industrial, wholesale, retail, and household refrigeration systems used for the processing, storage, and dispensing of food and food products; but excluding systems referred to on List A or List B.

(b) For maintenance of the specified refrigerating and air conditioning systems and special uses, as described on List C.

(c) For maintenance of all other refrigeration and air conditioning systems not included under (a) or (b) above, and not on List A or List B. This class includes sealed railroad cars.

Class V: Charging new refrigeration and air conditioning systems in the field except those systems owned and operated by the Army, Navy, Maritime Commission and War Shipping Administration, and excluding comfort cooling systems.

Class VI: Charging new equipment by an equipment manufacturer, exclusive of comfort cooling systems. This class does not include charging systems for Army, Navy, Maritime Commission and War Shipping Administration.

Class VII: Maintenance and repair of comfort cooling systems and maintenance and repair of refrigeration equipment used solely for storing or dispensing carbonated or malt beverages. This class does not include systems owned and operated by Army, Navy, Maritime Commission or War Shipping Administration.

Class VIII: Inventory—Surplus refrigerants in excess of one month's anticipated requirements.

(c) *Certification of orders by users, and deliveries thereunder*—(1) *Orders must be certified.* On and after July 15, 1943, no user shall place an order with a supplier or any other person, and no supplier or other person shall accept such an order, for any chlorinated hydrocarbon refrigerants unless such order (or vendor's delivery receipt) is accompanied by a certificate endorsed thereon, or attached to it, showing the uses for which the refrigerants are required, and in substantially the following form:

The undersigned purchaser hereby certifies to the seller and to the War Production Board that he has no empty or surplus cylinders, and that the refrigerants covered by this order are required for immediate use for the following purposes, as classified in Conservation Order M-28:

Classification (Here list classifications included in the purchase order and the specific use if in Class IV.)	*Quantity Required* (Here list minimum operating charge, in pounds, of refrigerant for each classification and for each specific use if in Class IV.)

Such certificate shall in every case be signed by the user or his authorized official, either manually or as provided in Priorities Regulation No. 7. It shall constitute a representation to the War Production Board, as well as to the supplier, that the facts stated therein are true. No supplier shall make any delivery under such an order if he knows, or has reason to believe, that such certificate contains any false, inaccurate or incomplete statement. He may rely thereon if he does not know or have any reason to believe that a certificate is inaccurate, incomplete or false.

On and after July 15, 1943, no supplier shall deliver any chlorinated hydrocarbon refrigerants except pursuant to an order accompanied by such a certificate as provided for above.

(2) *Deliveries to be subject to restriction.* If and whenever any use shall be prohibited, as provided in (g) below, no user shall install or use any chlorinated hydrocarbon refrigerants for such a use, regardless of the purpose for which it was acquired.

(d) *Certification of orders by suppliers; records; deliveries by suppliers*—(1) *Orders must be certified.* On or before July 15, 1943 and on or before the 10th day of each calendar month thereafter, each supplier who wishes to secure delivery of chlorinated hydrocarbon refrigerants through any contract agent during the next calendar month, shall place his order for such refrigerants with the contract agent. No supplier shall place such an order with a contract agent, and no contract agent shall accept such an order unless it is accompanied by a certificate endorsed thereon or attached thereto showing the uses for which the refrigerants are acquired, and the supplier's deliveries during the preceding month, in substantially the following form (except that deliveries made prior to July 15, 1943, may be estimated):

The undersigned purchaser hereby certifies to the seller and to the War Production Board that to the best of his knowledge, information and belief, the quantities of chlorinated hydrocarbon refrigerants covered by this order will be required during the next calendar month for deliveries by him for the following classified purposes, as described in Conservation Order M-28; and that he made deliveries during the preceding month of ..... as shown below:

Classification	Quantities required	Deliveries in preceding month
(Here list classifications included in purchase order)	(Here list quantity, in pounds, ordered for each classification)	(Here show quantities delivered in preceding month for each classification)

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Such certificate shall in every case be signed by the supplier or his authorized official, either manually or as provided in Priorities Regulation No. 7. It shall constitute a representation to the War Production Board as well as to the contract agent that the facts stated therein are true. No contract agent shall approve or request any such delivery if he knows or has reason to believe, that such certificate contains any false, inaccurate or incomplete statement. He may rely thereon if he does not know or have any reason to believe that a certificate is inaccurate, incomplete or false.

On and after August 1, 1943, no contract agent shall approve or request delivery of any chlorinated hydrocarbon refrigerants to any supplier except pursuant to an order placed, and accompanied by such a certificate, as provided for above.

(2) *Records must be kept.* Each supplier shall keep records showing the quantities of chlorinated hydrocarbon refrigerants delivered by him during each month for the various uses as classified in paragraph (b) above and the quantities of such refrigerants allocated to him each month for deliveries in each of such classifications.

(3) *Deliveries of dichlorodifluoromethane (sometimes called "F-12") after September 7, 1943, for uses in (c) of Class IV and (a) and (b) of Class III.* (i) Dichlorodifluoromethane (or "F-12") will not be allocated for the uses included in part (c) of Class IV, or in parts (a) and (b) of Class III, by means of regular monthly deliveries to suppliers.

(ii) Instead in the event a system of any type which is included on List C (in Class IV (c)) should become inoperative for lack of the refrigerant a separate application for the refrigerant must be made by the owner of the system, directly to the War Production Board, General Industrial Equipment Division, by letter, telegram, or other communication, stating (*a*) whether the system is used for air conditioning or refrigeration, (*b*) its size or capacity by horsepower or tons of refrigeration, (*c*) the minimum operating charge necessary to restore the system to operation, (*d*) why conversion to another type of refrigerant is not practicable, (*e*) the functional use of the system in the plant and (*f*) the end product being processed by its use. If the application is granted, the Board will issue a specific direction to the producer authorizing and directing delivery of a specified quantity to be made to the owner of the particular system for the use specified. No user, supplier, or other person shall deliver any dichlorodifluoromethane (or "F-12") to the owner of such a system unless and until the Board has specifically directed such delivery to be made.

[1]Formerly Part 970, § 970.1.

(iii) An equipment manufacturer who needs dichlorodifluoromethane (or "F-12") for charging new systems for the Maritime Commission or War Shipping Administration at the factory or in the field (included in parts (a) and (b) of Class III) must make a separate application directly to the War Production Board, General Industrial Equipment Division, by letter, telegram or other communication stating the procurement order number and (*a*) if the refrigerant is for factory charging, the minimum amount which he will need to meet his scheduled deliveries for the next month, and what part of the amount is for spare charges, or (*b*) if for charging in the field, the minimum amount, in addition to his inventory available for such use, which he will need during the next month to meet the ship-launching schedule. If the application is granted, the Board will issue a specific direction to the producer authorizing and directing delivery of a specified quantity to be made to the equipment manufacturer for the use specified. No person shall deliver any such refrigerant to an equipment manufacturer for such purpose unless and until the Board has specifically directed such delivery to be made.

(iv) This paragraph (d) (3) shall be followed, as long as it remains in effect notwithstanding any other provisions of this order. However, suppliers will continue to place their orders for refrigerants, for uses described in Class III, in parts (a), (b) and (c) and Class IV in parts (a), (b) and (c) in accordance with paragraph (d). When an application is made in accordance with this paragraph, (d) (3), the user is not required to furnish the certificate referred to in paragraph (c) (1).

(4) *Deliveries by suppliers during August* 1943 *and subsequent months.*—(i) During the month of August, 1943, and each succeeding calendar month, no supplier shall deliver for any use a greater quantity of refrigerants than is allocated to him during such month for that use, except as provided in (ii) below. A supplier shall rely upon the notification given him, by the contract agent with whom his order was placed, as to the quantities allocated the supplier for each of such uses during each calendar month, unless he knows or has reason to believe that such notification is incorrect, incomplete or false.

(ii) If a supplier has exhausted the quantity allocated him for classifications I, II, III, or IV during any calendar month, he may use his supply in classification VIII for the classification exhausted. If classifications IV and VIII become exhausted, he may then draw upon the supply allocated for classifications V or VI.

(iii) No supplier shall deliver during any month any such refrigerants allocated to him for delivery to or for use by the Army, Navy, Maritime Commission, or War Shipping Administration (Classes I, II and III) for use by any other person during that month; and no supplier shall deliver to or for use by any of such agencies any refrigerants which were allocated to him for civilian uses(Classes IV, V, and VI) during that month.

(iv) Any chlorinated hydrocarbon refrigerants allocated for classifications I through VII during any month and not delivered by the supplier during the month shall be transferred by him to classification VIII (Inventory), at the end of such month. If notice of his allocations for the following month has not been received by the first day of the month, the amount transferred to Class VIII (Inventory) from any classification may continue to be used for such classification; provided that the amount so used is restored to Class VIII, by deduction from the new allocation for that classification, as soon as notice of the new allocation for such month is received.

(e) *Certification of orders by contract agents, equipment manufacturers, and insecticide manufacturers*—(1) *By contract agents.* On or before the 20th day of each calendar month, commencing with the month of July, 1943, each contract agent who transmits orders for chlorinated hydrocarbon refrigerants from suppliers to a producer, for delivery during the next calendar month, shall place a written request for shipments, covering all of such orders, with the producer. No contract agent shall place such orders with a producer, and no producer shall accept such orders unless accompanied by the request with a certificate endorsed thereon or attached thereto, showing the uses for which the refrigerants are ordered, and deliveries made during the preceding month by suppliers placing orders through the agent, and in substantially the following form (except that deliveries prior to July 15, 1943 may be estimated):

The undersigned contract agent hereby certifies to the producer and to the War Production Board that he has received orders for shipment of the quantities of chlorinated hydrocarbon refrigerants covered by this request for shipments, for the following classified purposes as described in Conservation Order M-28; and that deliveries during the preceding month of ..... were made as shown below:

Classification	Quantities requested	Deliveries in preceding month
(Here list classifications included in all purchase orders)	(Here list aggregate quantity in pounds ordered for each classification by suppliers)	(Here show aggregate quantities delivered in preceding month for each classification, as shown by suppliers' certificates)

Such certificate shall in every case be signed by the contract agent or his authorized official, either manually or as provided in Priorities Regulation No. 7. It shall constitute a representation to the War Production Board as well as to the producer, that the facts stated therein are true. No producer shall make any such shipment or delivery if he knows, or has reason to believe, that such certificate contains any false, inaccurate or incomplete statement. He may rely thereon if he does not know or have any reason to believe that a certificate is inaccurate, incomplete or false.

(2) *By equipment and insecticide manufacturers.* On or before the 20th day of each calendar month, commencing with the month of July, 1943, each equipment manufacturer or insecticide manufacturer who wishes to secure delivery of chlorinated hydrocarbon refrigerants from a producer during the next calendar month shall place his order for such refrigerants with the producer. No such manufacturer shall place such an order with a producer, and no producer shall accept such an order unless it is accompanied by a certificate endorsed thereon or attached thereto, showing the uses for which the refrigerants are acquired, and the quantities used during the preceding month, in substantially the following form:

The undersigned purchaser hereby certifies to the seller and to the War Production Board that, to the best of his knowledge, information and belief, the quantities of chlorinated hydrocarbon refrigerants covered by this order will be required by him during the month of ..... for the following purposes, according to the classifications described in Conservation Order M-28 (or for the production of insecticide for the Army or for the Navy); and that he used such refrigerants during the preceding month of ..... as shown below:

Proposed use	Quantities required	Used in preceding month
(Here show whether proposed use is for insecticide, or for classifications under M-28, or for each)	(Here list quantity, in pounds, ordered for each use, or classification.)	(Here show quantities used in preceding month for each.)

Such certificate shall in every case be signed by the equipment or insecticide manufacturer or his authorized official, either manually or as provided in Priorities Regulation No. 7. It shall constitute a representation to the War Production Board, as well as the seller, that the facts stated therein are true. No producer shall make any delivery under such an order if he knows, or has reason to believe, that such certificate contains any false, inaccurate or incomplete statement. He may rely thereon if he does not know or have any reason to believe that a certificate is inaccurate, incomplete or false.

On and after August 1, 1943, no producer shall deliver any chlorinated hydrocarbon refrigerants to any equipment manufacturer or insecticide manufacturer except pursuant to an order placed, and accompanied by such a certificate, as provided for above.

(f) *Shipments by producers*—(1) *Statement of requested shipments.* On or before the 25th day of each calendar month, commencing with the month of July 1943, each producer shall file with the War Production Board a statement showing: the orders for chlorinated hydrocarbon refrigerants which have been transmitted to him by contract agents, or which have been placed with him by equipment and insecticide manufacturers, for delivery during the next calendar month, and the uses for which the refrigerants are ordered, as indicated by the certificates accompanying the orders; the quantity of such refrigerants which will be available for delivery by him, during such month; and his deliveries of such refrigerants to the suppliers and equipment and insecticide manufacturers, during the preceding calendar month (except that deliveries to suppliers prior to August 1, 1943, need not be shown by classifications).

(2) *Deliveries by producers.* On and after July 10, 1943, no producer shall deliver any chlorinated hydrocarbon refrigerants to any person, or for any use, except in accordance with specific directions from the War Production Board. Such directions will be issued primarily to insure the meeting of defense requirements, and of the more essential needs if and whenever all cannot be met. Such directions may specify the aggregate quantities of such refrigerants which shall be delivered by the producer during any calendar month (or other period) for any of the classifications of uses established by this order or for other requirements (including Lend-Lease, and the production of insecticide, separately, for Army and Navy use), or the pro ration of the available supply among all or any part of the various classifications and other requirements, or establish a reserve or emergency stock to be held by the producer. Such directions may also direct the producer to make such adjustments in his deliveries as may appear reasonable and appropriate to equalize the inventories held by suppliers, so as to more nearly assure all suppliers of a minimum working inventory whenever practicable. Directions issued under this order to a producer and directing deliveries to be made by him for specified uses or in specified quantities shall be deemed allocations of the refrigerants for the purposes specified and, subject to the provisions of this order, no producer, supplier, equipment manufacturer or insecticide manufacturer shall make or receive delivery for any other purpose.

(g) *Prohibited uses (List B), emergency cases.* (1) No user, supplier, contract agent, or producer shall deliver or cause to be delivered to the owner of any system, any chlorinated hydrocarbon refrigerants for use in, or for resale for use in any system of the types described on List B, made a part of this order. Such list may be changed from time to time (from month to month, or otherwise) by amendments to this order, as the War Production Board may consider necessary to assure sufficient supplies of such refrigerants in all areas and for the uses which are deemed most essential to the national defense.

(2) An authorization for an exemption from the terms of paragraph (g) (1) above may be allowed by the War Production Board when an air conditioning system must be operated (i) to avoid intolerable conditions in sealed or substantially airtight rooms or enclosures used for essential purposes, or (ii) to protect the life or health of a person under care of a licensed physician. An exemption from the requirement of paragraph (d) that a supplier's order must be placed by the 10th of the month preceding that in which delivery is required, may be allowed when the supplier demonstrates that, due to causes beyond his control, it will be impossible for a delivery in classifications I, II, III or IV to be met by him or any other supplier or user unless an exemption is allowed. Application for such an authorization may be made by or on behalf of the person affected by such restriction, by letter or telegram or other communication addressed to the General Industrial Equipment Division, War Production Board,

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stating facts sufficient to enable the Board to determine the necessity for such authorization. If granted, the authorization may be by letter or telegram, and shall be transmitted by the applicant to the person who will supply such refrigerants, and shall be deemed an authorization to any user or supplier to furnish or install the minimum operating charge necessary to maintain such system in adequate operation.

(h) *Notification of customers.* Any producer, contract agent, supplier, or person who is prohibited from or restricted in making deliveries of any chlorinated hydrocarbon refrigerants by the provisions of this order, and any producer who is prohibited from or restricted in making any such deliveries by any directions issued hereunder and received by him from the War Production Board, shall as soon as practicable notify each of his regular customers of the requirements of this order or of such directions; but the failure to give such notice shall not excuse any customer from the obligation of complying with any requirement of this order, or of any such directions applicable to such customer and of which he has notice.

(i) *Effect of preference ratings.* The provisions of this order shall be followed by every producer, contract agent, supplier, user, equipment manufacturer, insecticide manufacturer, and any other person buying, selling or delivering chlorinated hydrocarbon refrigerants, without any regard to any preference ratings which have been assigned or which may hereafter be assigned to particular contracts or orders.

(j) *Miscellaneous provisions*—(1) *Applicability of regulations.* This order and all transactions affected thereby are subject to all applicable regulations of the War Production Board, as issued and amended from time to time.

(2) *Monthly reports.* Each person (including a producer, contract agent, supplier, equipment manufacturer, insecticide manufacturer, user, or owner of refrigerating or air conditioning systems) who has in his possession on the 15th day of any calendar month in excess of 500 pounds of any type of chlorinated hydrocarbon refrigerants, and any person who sold in excess of 2,000 pounds of any type of such refrigerants during the preceding calendar month, shall file with the War Production Board, on or before the 20th day of each month, commencing with the month of July 1943, a report on Form WPB-3054 prepared in accordance with the instructions for such form.

(3) *Violations.* Any person who wilfully violates any provisions of this order, or who, in connection with this order, wilfully conceals a material fact or furnishes false information to any department or agency of the United States is guilty of a crime, and upon conviction may be punished by fine or imprisonment. In addition, any such person may be prohibited from making or obtaining further deliveries of, or from processing or using, materials under priority control, and may be deprived of priorities assistance.

(4) *Appeals.* Any appeal from the provisions of this order, or any direction thereunder, shall be made by filing a letter in triplicate, referring to the particular provision appealed from and stating fully the grounds of the appeal.

(5) *Communications.* All reports to be filed and other communications concerning this order should be addressed to: War Production Board, General Industrial Equipment Division, Washington 25, D. C., Ref: M-28.

NOTE: The reporting requirements of this regulation have been approved by the Bureau of the Budget in accordance with the Federal Reports Act of 1942.

Issued this 7th day of September 1943.

WAR PRODUCTION BOARD,
By J. JOSEPH WHELAN,
Recording Secretary.

LIST A: "Comfort cooling system" means any system, of any size, operated or installed for the purpose of lowering the temperature and/or humidity of air in any building, room or other enclosure used as, or located in any of the following:

Amusement parks.
Animal hospitals.
Auditoriums.
Ballrooms, dancing studios and dance halls.
Bank and loan associations.
Bars, cocktail lounges, and beer parlors.
Bowling alleys.
Concert halls.
Funeral parlors.
Golf clubs, country clubs, and athletic clubs.
Hotels and apartment houses.
Moving picture houses.
Night clubs.
Office buildings and offices, public or private.
Railway, streetcar and bus stations and terminals.
Residential buildings and dwellings of all kinds.
Restaurants, cafeterias, and other places selling meats, food or beverages.
Schools.
Service establishments, such as laundries, cleaners and dyers, tailor shops, barber shops, "beauty" parlors, automobile sales and service shops, and repair shops of all kinds.
Skating rinks.
Stores, selling any kind of products, material or merchandise, at retail or wholesale (excluding manufacturing establishments).

The term "comfort cooling system" shall not include (i) any such system used to air condition a building, room or other enclosure used chiefly for purposes not listed above, or (ii) any system designed, necessary and used, in substantial part for the refrigeration and storage or processing of food, ice, or other materials or products requiring refrigeration, temperature control, or freedom from dust or other impurities, or (iii) such part of a system as may be necessary and used for the circulation of air, or necessary and used for raising the temperature of air during cold weather to a degree which is comfortable or tolerable for persons (comfort heating).

LIST B: Systems for which chlorinated hydrocarbon refrigerants shall not be delivered.

Systems:	*Effective date*
Comfort cooling systems	June 1, 1943
Skating rink systems	June 1, 1943
Refrigeration systems solely for storing or dispensing carbonated or malt beverages	July 1, 1943

LIST C: Systems and special uses, referred to in Class IV (b), for which a minimum operating charge (or the minimum quantity necessary for a special use, or for a "standby charge") of dichlorodifluoromethane (or "F-12") may be obtained by a user from any supplier, without a specific authorization from the War Production Board, if the supplier has on hand any such refrigerant which were allocated to him for uses covered by Class IV (b), or are carried over from his previous month's supply and are available for such use in accordance with paragraph (d) (4) (iv). A "standby charge" may be delivered only where specifically mentioned below. The systems covered by this list include only those which are operated for air conditioning or refrigeration exclusively for one or more of the following purposes:

AIR CONDITIONING

1. Air conditioning equipment in crane cabs.
2. Air conditioning in communication rooms which are sealed, including telephone or telegraph relay stations and exchanges and control rooms of radio stations, if no other rooms are conditioned by the system.
3. Air conditioning to maintain prescribed conditions in laboratories where the tests being conducted are directly concerned with the production of parts or instruments for aircraft, combat tanks, ships, radio and radar equipment and other military combat equipment.
4. Air conditioning for temperature and humidity control in the production of gyroscopic instruments and compasses.
5. Air conditioning for temperature and humidity control in the production of turbo superchargers.
6. Air conditioning for temperature and humidity control in hospital operating rooms.
7. Air conditioning for humidity controls in annealing furnaces.
8. Air conditioning for temperature and humidity control in electro-drying of aluminum castings containing a percentage of magnesium, (including standby charge).
9. Air conditioning for humidity control for production of optical products going into the production of fire control instruments for range finding, etc., Army and Navy telescopes, height finders, bombsights, and air borne control station computors.
10. Air conditioning for the production and storage of penicillin and blood serum, (including standby charge).

REFRIGERATION

1. Low temperature metal shrinking cabinets.
2. Low temperature rivet storage for aircraft production.
3. Cooling of oil or other coolant in high speed machining and cutting operations in the production of military aircraft and other combat vehicles.
4. Cooling of anodizing solutions where the product produced is used directly in military ordnance material.
5. Controlling reactions in photographic solutions for the development and printing of X-ray, news, and motion picture film or prints.
6. Cooling of X-ray apparatus used in the analysis of castings in the production of aircraft and other combat vehicles, or pressure vessels.
7. Cooling of rollers or mixers in the production of synthetic rubber.
8. Low temperature cabinets for the testing of combat instruments.
9. Variable temperature cabinets for the testing of radio sending and receiving sets for installation in military aircraft or other combat vehicles or portable radio transmitter-receiver sets for military use.
10. Variable temperature cabinets for the testing of radar equipment for installation in military aircraft and Navy vessels.
11. Low temperature chambers designed to duplicate substratospheric conditions for the testing of instruments, flying clothes, personnel and equipment.
12. Refrigeration for the production and storage of penicillin and blood serum, (including standby charge).
13. Refrigeration for the storage of blood for plasma, production of blood plasma and storage of blood plasma, (including standby charge).
14. Refrigeration for cooling of welding tips used on spot-welders in the production of military aircraft.

SPECIAL USES

1. Testing of coaxial cable.
2. Cooling of transformers where no refrigeration equipment is involved in the process.
3. Charging of gas filled condensers for radio frequency equipment.

(INTERPRETATION 1)

a. *Reports of inventories.* The reporting requirements of paragraph (j) (2) of Order M-28 [§ 970.1] must be complied with

regardless of whether the chlorinated hydrocarbon refrigerants are being held by the owner for his own use or for resale.

The paragraph requires every person (including the owner of a refrigerating or air conditioning system) who has in his possession, on the 15th day of any calendar month (commencing with the month of July), more than 500 pounds of any type of chlorinated hydrocarbon refrigerants, or who sold more than 2,000 pounds of such a refrigerant during the preceding calendar month, to file a report on Form WPB-3054 with the War Production Board on or before the 20th day of the month.

Each "person," as defined in the order, must report the aggregate quantities in his possession (including stocks of less than 500 pounds located at various places) if the total is more than 500 pounds.

The report must include all amounts not actually being used in refrigerating or air conditioning systems. Thus the owner or operator of a system who has more than 500 pounds in his possession must report his entire supply except for the minimum operating charge actually installed in his system. Any additional amount which he may have must be reported, whether kept in cylinders, a storage receiver or other form of container. However, if a minimum operating charge is being temporarily held in a container while the system in which it had been installed is being repaired, it should not be reported.

An equipment manufacturer who has more than 500 pounds in his possession on the 15th day of any calendar month must report his entire supply except what has been actually installed as an operating or holding charge in accordance with his regular manufacturing practice.

b. *Charging of equipment manufacturers.* Paragraph (g) provides that no user, supplier, contract agent, or producer shall deliver or cause to be delivered, to the owner of any system any chlorinated hydrocarbon refrigerants for use in, or for resale for use in any system of the types described on List B.

This restriction is intended to prevent charging any system of the types included on List B with chlorinated hydrocarbon refrigerants except for a person who was operating a system and had the necessary refrigerants in his possession on the effective date specified in List B. Therefore, a manufacturer may not charge any such system with chlorinated hydrocarbon refrigerants before delivery, and he may not deliver the refrigerant separately to be used in charging the system. However, he is not restricted from delivering systems which had already been charged with such a refrigerant on the effective date specified on List B. (Issued July 29, 1943.)

Mineral Wool Insulation Makers May Adjust Prices (MPR 188)

Manufacturers of mineral wool insulation, including building and industrial products made from mineral wool, were permitted last month by the Office of Price Administration to use the special "national or general shortage" provisions for the adjustment of maximum prices which have been made available by OPA to producers of two other types of building materials.

The action permits mineral wool insulation producers to use the adjustment provisions contained in order A-2 of maximum price regulation 188 (manufacturers maximum prices for specified building materials and consumer goods other than apparel).

The new provisions permit the granting of relief to cover total manufacturing costs to (1) manufacturers who are unable to maintain or expand production under existing maximum prices wherever there is a general shortage and the production of each producer is needed, or (2) where the loss of the seller's production would result in higher consumer prices.

The action, contained in amendment 3 to order A-2 of regulation 188, will not affect prices at consumer levels since distributing levels are not given permission to pass on the increased cost.

To assist manufacturers, applicants for adjustment may obtain from OPA advice as to the specific information that will be required in order that applications may receive prompt attention.

Highlights of Ration Order No. 19 on Anthracite Coal

The major provisions of the Office of Price Administration's ration order 19 on anthracite coal, which became effective September 1, were outlined in a fuel oil industry letter issued by the OPA's fuel rationing division September 10.

The order applies to the New England states and to New York, Pennsylvania, New Jersey, Delaware, Maryland, Virginia, and the District of Columbia. The order does not establish a consumer coupon rationing plan, but is designed to prevent unlimited accumulation of anthracite coal inventories early in the season by some consumers. It covers deliveries to consumers for space heating, domestic hot water, or domestic cooking. It does not apply to consumers using coal for industrial processing or for the production of power, or for the space heating incidental thereto.

In general, the order prevents a dealer from making a delivery to a consumer if the delivery will bring the consumer's inventory to more than one-half the consumer's consumption in the base year of April 1, 1942, through March 31, 1943.

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Recent Amendments to Fuel Oil Rationing Order

An index to amendments Nos. 1 to 50 to the fuel oil rationing order appeared on pp. 171-172 of the April HPAC. Amendments 51-60 were covered on p. 233 of the May HPAC, amendments 61-65 on p. 52, front section, June HPAC, amendments 66-71 on pp. 411-412 of the August HPAC, and amendments 72-73 on p. 466 of the September HPAC. The following information on amendments 74-78 has been taken from OPA fuel oil industry letters issued last month:

Amendment 74, effective August 18, 1943, provides for the reissuance of rations for heat and hot water in Washington, Oregon, and Idaho. Based upon the results of a recent survey, it makes certain upward adjustments in the rations for small homes in that area.

Amendment 75, effective August 20, provides a working inventory reserve for commercial, industrial, and governmental consumers in order to assure maximum production efficiency and to avoid disastrous shutdowns in the event that fuel oil deliveries are temporarily halted. Application for inventory reserve is made to the district director. Reserve may be unfilled storage capacity or the amount of the largest quarterly ration, whichever is smaller, except that district director has discretion to increase the reserve to an amount not exceeding twice the current quarterly ration. On notice from the district offices, applicant's local board will issue either coupons or deposit certificates to cover inventory reserve.

Amendment 76, effective August 27, provides that all heat and hot water consumers in premises other than private dwellings (1101 applicants) whose consumption for the current heating year was less than 10,000 gal, will be granted fuel oil rations regardless of the convertibility of their heating equipment. This amendment permits concentrating the conversion program on the larger consumers where greater gallonages can be conserved with the smallest use of critical materials and without placing an additional burden on the already overtaxed retail coal delivery facilities.

Amendment 77, effective September 13, provides for the issuance of heat and hot water rations for the 1943-44 heating year for new applicants and those consumers who have moved into new quarters and are therefore not eligible for renewals of last year's rations. It restricts the issuance of heat and hot water rations to premises which are used for residential or occupational purposes. Since renewal of 1942-43 heat and hot water rations for the new season, and the early issuance of 1943-44 new applicants' rations made unnecessary the issuance of supplemental and substitute heat and hot water rations for the remainder of the 1942-43 heating season, this amendment limited the issuance of such rations to persons applying prior to September 1.

Amendment 78, effective September 1, revokes the old prohibition against the issuance of fuel oil for boats used for non-occupational and pleasure purposes, and, in conformity with similar changes in the gasoline regulations, establishes a ceiling for non-occupational uses of a boat, or for occupational uses which involve pleasure cruising, guiding, fishing parties or sightseeing. These restrictions apply uniformly throughout the limitation area, except in the Pacific northwest where, similar to the gasoline rationing regulations, no ceiling other than need is imposed if the boat is commercially used even for pleasure purposes.

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Pipe Fittings Simplification Order L-288 Amended

Limitation order L-288 governing grey cast iron, malleable iron, and bronze and brass pipe fittings was amended September 22 by the War Production Board to add an item to the appendix listing pipe fittings which can be manufactured under the order. The amendment adds the 4 in. 300 psi SWP (steam working pressure) malleable iron female ground joint union to the appendix. The amendment also adds the ½ x ½ x ¾ reducing tee to the list of permitted reducing tees under Table 2, grey cast iron pipe fittings. This item previously had been omitted from the list of reducing tees by an error in printing.

OPA Regulates Used Pressure Vessel Prices by Order MPR-465

More than 2600 dollars-and-cents prices for 1300 sizes and combinations of used pressure vessels and used enclosed atmospheric pressure vessels — cylindrical tanks made of black steel and used for many industrial purposes requiring the holding of gas or liquids under pressure— were established September 13 by the Office of Price Administration to replace formula ceilings for these items.

Generally the specific maximums listed in the action reflect the March 31, 1942, level for these used articles and continue the price level set previously by maximum price regulation 136 (machines and parts and services). New pressure vessels, new enclosed atmospheric pressure vessels, and new open vessels remain under the maximums prescribed by regulation 136.

The action, in placing the used pressure vessels under a separate regulation, was one step in a series planned by OPA to transfer other second hand machines and parts, wherever possible, from the overall machinery regulation to separate measures and specific ceilings. Since the present pricing technique involves a formula based on the value of used machines in comparison with equivalent new machines, specific maximums will eliminate lengthy and involved price computations, facilitate transactions and will make compliance by buyer and seller substantially easier while it assists OPA in enforcement.

Ceilings are provided in the new measure — maximum price regulation 465 (used pressure vessels and used enclosed atmospheric pressure vessels), which became effective September 27, 1943—for two classes of vessels. The flat maximum prices for "reconditioned and guaranteed" vessels, regardless of age, are based upon 85 per cent of maximum prices for sale of the vessel when new. The maximum prices for used vessels that cannot qualify as reconditioned and guaranteed are based upon 55 per cent of the ceiling for the vessel when new. The same percentages were the base for reconditioned and "as is" vessels in the machinery regulation.

The listed ceilings have been adjusted to compensate for the difference in prices of new riveted and new welded vessels, as well as for the difference in prices between new horizontal and new vertical vessels.

PAW STOPS OIL CONVERSIONS

The Petroleum Administration for War announced September 23 suspension of its program for conversion of industrial and commercial oil burning equipment because of the uncertainties of the coal situation. PAW warned, however, that this does not mean we are "over the hump" as far as oil supplies are concerned. War developments may make it necessary to resume the conversion program later.

The suspension does not apply to conversion projects which are now in process.

Bureau of Mines Studies Metal Dust Hazards

To safeguard the lives of industrial workers and to minimize the dangers of fires and explosions in war plants, the Bureau of Mines has ascertained the inflammable characteristics of many of the powdered metals used or produced in factories turning out weapons and other equipment for the nation's fighting forces.

Founded upon many years' experience in the testing of the inflammable characteristics of coal mine dust, the bureau's work in the powdered metals field is being conducted at its laboratories at Bruceton, Pa., where some of the equipment used for the mine dust work has been modified to handle the metallic dusts and other powdered material submitted by industries.

Large quantities of metallic powders are being produced in the United States for the war and most of these powders are inflammable or can enter into and propagate an explosion under certain conditions, the bureau reports.

During the past fiscal year, the bureau's laboratories conducted experiments on 70 samples of various powders, such as dusts from coal mines, metal powders, synthetic resins, wood pulp, shellac, cottonseed hull bran, and dust from powder plants, steel mills, and metallizing operations. Another phase of this work was the testing of powders suggested as extinguishers for incendiary bombs, according to Dr. A. C. Fieldner, chief of the Bureau's fuels and explosives service, who directs the research program. With such information, plant officials are able to work out effective protective measures.

Among the metallic dusts tested were aluminum, antimony, cadmium, chromium, copper, iron, lead, magnesium, tin, zinc, and zirconium.

Zirconium, a costly metal which is used in ammunition primers, has been described as "particularly dangerous" by the bureau's research workers, says Dr. R. R. Sayers, bureau director. In the tests at Bruceton, a cloud of zirconium powder ignited spontaneously at room temperature and exploded, whereas other metallic dusts in the "highest explosibility" class required temperatures hundreds of degrees higher before they ignited. As a result of the tests, the bureau recommends that powdered zirconium be handled only as a sludge or in special containers. Zirconium has a wide range of industrial uses and is employed, in various forms, in welding rod flux, in radio tubes, in the production of armor plate, and in furnace refractories.

Some of the bureau's work in the testing of metallic dusts is described in Bureau of Mines information circular 7241, Annual Report of Research and Technologic Work on Coal, Fiscal Year 1942, by Dr. Fieldner and W. E. Rice, senior fuel engineer.

SIMPLIFIED MATERIAL LIST FOR L-41 PROJECTS

A simplified material list has been provided to accompany the War Production Board application form for authorization to construct under order L-41 and for priorities to obtain building materials. Property owners, builders, and others planning conversion of houses and other structures into additional living units will use the new form, designated as WPB 2897.1, Bill of Materials to be Installed in Residential Remodeling, Rehabilitation or Additions and New Housing under $10,000 Total Cost. The form takes up only a single sheet of paper and replaces WPB 2897 (formerly PD-105-A) for construction of this type. It is used to accompany the application form WPB 2896 (formerly PD-105).

The new form is applicable for use in three types of war housing construction: (1) privately financed conversion, rehabilitation, or additions; (2) publicly financed conversion; and (3) new private housing projects where all units involved amount to less than $10,000 total cost exclusive of land.

Additional War Housing Needed, NHA Analysis Shows

While almost 1,500,000 new war housing units have already been completed or placed under construction, expanding employment needs in many key war industries will require a substantial additional volume of housing to accommodate incoming workers during the next 10 months, John B. Blandford, Jr., administrator of the National Housing Agency, said last month.

The NHA is completing an analysis of prospective future war housing needs in all important war industry localities, based on the most complete information obtainable on production schedules, manpower requirements, and the additional in-migration of labor necessary to meet production goals, Mr. Blandford said.

This survey indicates that additional war housing needs will be concentrated largely on the west coast and in southwestern and southeastern areas, where new industrial facilities are being brought into large scale production or where existing plants are stepping up their operations. In other sections of the country, except at scattered points, the war housing already available or under way appears to be generally in balance with present or prospective requirements of incoming war workers.

With completions of war housing this year having increased 50 per cent over the comparable preceding period, the supply of war housing has caught up with the immediate need in most areas, Mr. Blandford declared.

"However, in many essential lines of war supply and equipment, production is still some distance from the peak. This means that in many localities thousands of additional workers must be recruited. Since only part of this additional manpower can possibly be secured from resident workers, many thousands must be recruited elsewhere and these thousands will need housing."

Mr. Blandford emphasized that the NHA, through its war housing centers and their "share your home" campaigns, is intensifying its efforts to house war workers in existing dwellings and is confident that as many as 600,000 incoming war workers can be accommodated without new construction. Since 1940, more than 1,500,000 in-migrant workers have been provided for in this manner.

Nevertheless, the latest information on production and manpower requirements leaves no doubt that a considerable additional volume of new war housing will be needed through construction or conversion to accommodate the further in-migration of labor now in prospect, Mr. Blandford declared.

In programming this additional housing the NHA will continue its established policy of scheduling privately financed construction, intended for long term use, where there is reasonable likelihood of continued demand for the housing after the war, he said.

To meet that part of the war housing need which is most subject to shifts in wartime demands, the NHA will continue to schedule publicly financed temporary construction, requiring minimum expenditure of critical materials and money and which will be dismantled after its wartime usefulness has been served.

• WPB . . . OPA . . . PAW . . . Etc. •

WPB Field Offices Given Increased Functions

Thousands of application forms formerly routed to the War Production Board in Washington will now be processed in the field as a result of specific measures announced September 24 by H. G. Batcheller, WPB operations vice-chairman, to implement the decentralization policy announced previously. Co-incidentally, Mr. Batcheller revealed a reduction in CMP paper work which will have the result, after the first quarter of 1944, of eliminating two out of every three CMP 4-B quarterly applications, with authorizations made on an annual basis.

Under the new arrangements, field offices will have increased functions to perform in processing PD-1A applications; industrial projects under $10,000; emergency assistance applications (PD-333); and appeals under WPB orders.

In addition, a task committee appointed by Mr. Batcheller is now working with the industry divisions with the view of eliminating the largest possible volume of applications which industry is required to file with WPB.

Specifically, these are the changes in regional handling of WPB applications:

PD-1A applications: At present, field processing is limited to applications of less than $500 in value. This authority is now increased to applications up to a value of $1000, and after 90 days, the authority will extend to applications of a value of $2500.

Industrial Projects: On October 15, the field offices are scheduled to begin processing applications up to $10,000 in value (excepting certain types of projects), and this authority is to be increased to cases of $25,000 in value or less beginning January 15, 1944.

Emergency Assistance Applications (PD-333) — The field offices now process PD-333s up to a value of $500. This is to be increased to $1,000 within 30 days, and to $2,500 within 60 days. The authority to grant emergency AAA ratings, however, will remain with the Washington offices for the time being.

Appeals: At the present time, the field offices handle appeals under 60 WPB "L" and "M" orders, and are permitted only to deny such appeals, or to recommend approval; they are not permitted to make outright grants on appeals. Within the next few weeks, 136 additional orders will be referred to the field, with action limited as above on 66 orders, and limited to recommendations for denial or approval on the other 70 orders.

After the 136 orders have been in the field for 60 days, regional offices will be permitted to deny appeals in all cases, and to grant appeals in certain types of cases.

WPB Issues Order L-313 On Aircraft Fittings

The War Production Board issued September 24 an order implementing the policy of the armed services in standardizing aircraft plumbing fittings manufactured and used by the Army air forces and the Navy. Lack of standardization in the past is said to have prevented full production of the industry.

The Navy recently moved to standardize aircraft plumbing fittings, and the standardization program was furthered when the Army air forces issued a directive to airplane manufacturers stating that after certain dates airplanes would be accepted only with standard fittings.

The WPB action, which is contained in general limitation order L-313, provides that after March 1, 1944, no producer of aircraft plumbing fittings of the types known as Army-Navy aeronautical standard, air corps 810, air corps 811, naval aircraft factory, or similar types shall manufacture or deliver any type of fittings except these standard types for installation in aircraft and aircraft components.

Aircraft plumbing fittings are used for the connection of tubing, hose, or pipe installed in the assembly of aircraft and aircraft components for the purpose of making a fluid tight joint.

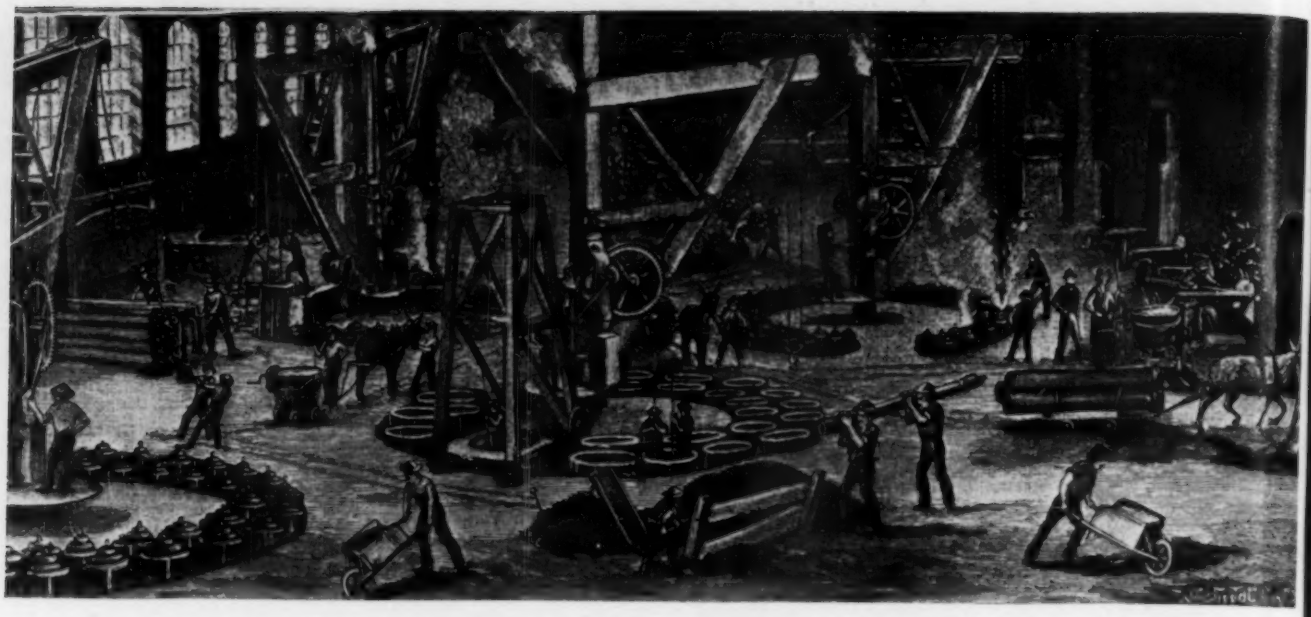
The provisions of the order will not apply in the following cases:

1) To the Army air forces or the Navy bureau of aeronautics on direct purchases.

2) To persons who have been specifically authorized to use other than A.N. standard fittings by the aircraft scheduling unit of the Aircraft Production Board, in the quantities and specifications set forth in the authorization.

3) To aircraft plumbing fixtures which are non-metallic.

4) For maintenance installation in aircraft in which types other than standard, delivered prior to March 1, 1944, were originally installed.



A view in an early pipe foundry, showing vertical casting

A HISTORY OF PIPING

M. A. Hasselmann Traces the Development of Cast Iron Pipe from "Way Back When"

THE HISTORY of cast iron pipe is a very interesting one and is an outgrowth of the re-invention of gunpowder and the invention of the ball-throwing cannon in 1313. An entry in the records of the city of Ghent for that year reads: "In this year was introduced the use of *bussen* in Germany by a monk." A manuscript of the year 1326 completely describes a gun and its operation.

The technique of casting cannon barrels laid the foundation for the manufacture of cast iron pipe. The stuckhofen, the ancestor of the modern blast furnace and indispensable to the manufacture of iron pipe, was developed between 1325 and 1350, to meet the requirements of early cannon manufacture. With it came the two-step method of processing iron—melting and fluxing the ore and casting it in pigs, then using the pigs to make wrought iron or remelting and refining them to make castings. The first cannon barrels were made of slabs of wrought iron, hammer welded together in several concentric layers. As a reinforcement, iron rings were shrunk on the barrels (applied hot and expanded and shrinking as cooled.)

The first cast cannon barrels were bronze, although cast iron cannon followed soon after, and both types were used for centuries thereafter. By 1500, casting methods were sufficiently refined that rifle barrels were cast, although that practice was short-lived.

As early as 1455 a cast iron water pipe line was installed at the Dillenberg castle in Germany, probably from pipe cast during peaceful times by foundries that otherwise cast cannon. Fountains erected in Germany in 1562 used cast iron pipe, and cast iron water lines were laid at Versailles, France, in 1664. By 1650 there were foundries in Germany ignoring ordnance and casting fireplace kettles, pipe, parts for iron stoves, etc.

First Pipe Cast Horizontal

The first cast iron pipe was cast in horizontal position, in rather short sections, with octagonal flanges cast integral at each end and with bolt holes cast in the flanges. The connecting bolts were of wrought iron and gaskets were of lead. Horizontal casting left flaws on the top side of the pipe, caused by air holes and sand pockets. Also, especially in the larger pipe, the core mold tended to float, making the top of the pipe thinner. Eventually the mold was tilted to 45 deg, the metal poured in at the topmost edge, drawing bubbles and impurities to that point. Soon afterward, however, the casting was done vertically.

Vertical casting was developed in England and an English patent

Vital to War

Piping is "man's greatest transportation system." Modern industry and our war effort depend upon pipe lines ranging in size from the big cross-country conveyors of oil, gas, and gasoline to the myriad small diameter tubing connections in, for example, an airplane engine test cell. . . . Mr. Hasselmann, of Tube Turns, Inc., has set himself the job of writing a history of piping. This is the fifth of a group of articles appearing in Heating, Piping & Air Conditioning. His material is expected to be available later in book form.

Centrifugal casting of pipe was invented in 1915

was issued in 1846. The method was introduced in America in the 1850's by two "imported" English craftsmen.

With vertical casting it was logical to put the mold down in a pit and the method became known as pit casting. It prevailed until the use of centrifugal casting became extensive, although some pipe has always been cast by the horizontal method. The casting of iron soil pipe, which became an industry of considerable size during the last half of the last century, was done horizontally, including the two-piece soil pipe. Two pressure pipe enterprises, both beginning operations in the 1920's and specializing in smaller sizes, used improved horizontal casting methods and were notably successful.

Centrifugal Casting

Centrifugal casting of pipe, using a metal mold, was invented in 1915. The principle involved is to rotate the external mold of the pipe at high speed and pour in the amount of molten metal necessary to make the desired thickness of pipe, continuing the rotation until the metal solidifies. No interior core mold is needed as the metal is thrown against the outside mold by centrifugal force and held there, maintaining a smooth inside surface. This centrifugal force also causes air and impurities (lighter) to be released inside the pipe, resulting in a more perfect as well as denser metallic structure. Centrifugally cast pipe is strong though light, and accurately formed.

A later centrifugal casting development involves a sand mold.

About 10 pipe makers in the United States use centrifugal casting of one type or another and produce about 75 per cent of all cast iron pipe by this method. It is interesting to note that the cast iron pipe industry, which borrowed its techniques from the cannon makers 500 years ago, is today paying back in kind: namely, centrifugal casting of gun barrels.

Other Developments

A significant development was that of the bell and spigot joint, invented by Thomas Simpson, engineer of the Chelsea Water Co. of London, in 1785. Simpson sought a boltless connection. At that time his company was relaying pipe originally laid in 1744, the joints of which had "perished" (connecting bolts rusted off.) Possibly he consulted the "wisdom of the ancients", for the essence of his connection was embodied in many of the baked clay, cut stone, and terra cotta pipes used 2000 and more years before.

Another significant development in the making of cast iron pipe was that of the special pipe foundry. The first of these was built in 1834. There has been a constant trend toward specialization and mechanization of cast iron pipe plants since that time, when the simplest of jib cranes, ladles, and waterpowered blowers (for the forced draft of cupolas and furnaces) were about the only machines in a foundry. Today, foundries have the traveling cranes and casting equipment that enables regular production of pipe as large as 84 in. diameter and 12 ft long.

Control over the purity of the metal or formula has been a constant development. The first metallurgist of record was E. A. Kebler, who came to a pipe plant at Cincinnati and Newport in 1883. Many years later he reminisced: "I . . . was probably the first chemist in the United States in a plant devoted entirely to the melting of iron. In those days the idea of a chemist was ridiculed by other pipe foundrymen."

Fittings and Joints

Fittings for large cast iron pipe have always been cast iron and usually have been cast right along with the pipe. Large cast iron fittings were also used in quantity with wood, wrought iron, and steel piping. Fittings for the smaller cast iron pipe have consistently been bronze, cast iron, or malleable iron.

In earliest usage flanged-at-both-ends cast iron pipe was the only kind available. Sections were

CAST IRON CONDUITS
FOR THE ALBANY WATER-WORKS, WANTED.

NOTICE is hereby given, that proposals in writing will be received by the subscriber, in behalf of the trustees of the Albany Water-works, for furnishing by contract, one hundred tons of cast iron conduits of a bore of six inches in diameter, three feet in length, and five-eights of an inch thick. The proposals are to be accompanied by two pipes connecting together, spigot and faced fashion with an entrance of two inches as samples of the casting and must be forwarded to the subscriber by the first day of May next, and are to specify the shortest time at which the above or any less quantity of such conduits can be delivered at the city of Albany.

By order of the Trustees of the Albany Water-works

JAS. VAN INGEN, *Clerk.*

Albany, March 18, 1813. 13

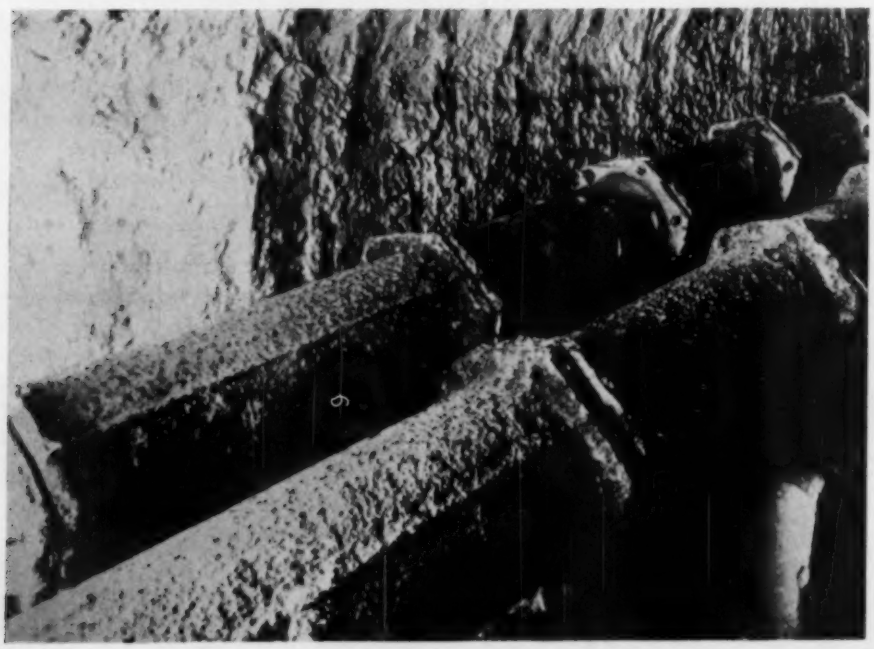
An advertisement which appeared in Albany, N. Y., in 1813, and probably was the first in the United States to mention cast iron pipe

bolted together with wrought iron bolts and gasketed with lead plates. After 1800 flanged joints were often gasketed with wrought iron rings wrapped with yarn that had been impregnated with a mixture of red lead and white lead. About 1830 the idea of machining the faces of flanges came into being and these were gasketed with rubber, copper, paper, or cement. Asbestos packings appeared in the latter part of the 1800's and laminated metal gaskets became available as boiler pressures exceeded 200 psi. One of the earliest applications of oxy-acetylene and electric welding was closing the connections between flanged cast iron pipe.

The majority of cast iron pipe is bell and spigot type, the shape and number of locking grooves depending upon the service involved. When first used, seals for bell and spigot joints were solid lead. Through the years many combinations of materials were tried, including iron borings. The present wrapped packing of impregnated yarn or jute, locked in and protected by caulking of lead, is well over 100 years old. Shredded lead, which can be pounded into a solid mass, is comparatively recent.

Threaded bell and spigot cast iron pipe connections have been used since the second quarter of the past century, first on small sizes, then on larger sizes as threads improved and wrenches permitted. Threads were coated with red and white lead, eventually with special dressings. Today, medium size cast iron pipe is available with threaded bell connections every other joint and with hexagon nuts cast in the pipe to facilitate turning. Threaded plugs (spigot ends only) are sometimes used to give a better grip to the lead packing.

Cast iron water mains serving the fountains and palace of Versailles since 1664



[Drawing of early foundry and photo of centrifugal casting, courtesy of U. S. Pipe & Foundry Co. Photo of mains at Versailles courtesy of Cast Iron Pipe Research Association. Reproduction of advertisement, courtesy of American Cast Iron Pipe Co. Of assistance in writing this installment was the paper, History of the Cast Iron Pressure Pipe Industry in the United States, by H. J. Noble of American Cast Iron Pipe Co.]

BACK THE ATTACK!
BUY MORE WAR BONDS

Comfortization of Airplanes—

(*Concluded from page* 517)

tomatic regulation of temperatures within airplane cabins, in conjunction with adjustable thermostats.

Numerous automatic safety controls serve particularly to minimize the hazards of internal combustion heaters. Among them are cutoff switches which operate, if there is too great a concentration of CO, thermostatic controls which turn the heater off in case of too great a heat output, and numerous others.

* * *

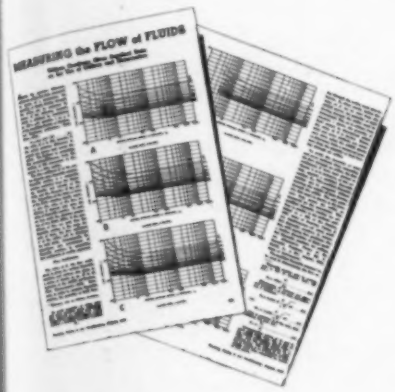
The problems of heat and air supply for aircraft are still only partly solved. This, however, is equally true for many other phases of airplane design, and the rapid advances made during the last few years indicate clearly that satisfactory solutions are in the offing.

The challenge to the ground air conditioning engineer does not primarily concern the solution of the mechanical problems but rather the need for qualified leadership in establishing the fundamental requirements and principles for this child of both ground air conditioning and aeronautics. Only if this challenge is met, the comfortization of postwar private and commercial aircraft can enjoy the full benefit of the pioneer work which had to be done in order to make American fighting aircraft superior and victorious.

"OPEN FOR DISCUSSION"

Comment from readers on HPAC's articles

Measuring the Flow of Fluids



THE EDITOR—

May I thank you for having sent me the extra copy of Mr. Goodman's article on orifice flow coefficients from your August issue, as I requested?

We expect to use the figures in this article in connection with our design problems involving orifices as metering elements.

I have no comments to offer on this material other than to point out that the method of presenting the design data is a much more useful one than is employed in the original ASME standards. In this respect, may I add my opinion to that of others who have felt that a correlation of flow coefficients which requires a trial-and-error procedure in design applications is rather ineffective?

The correlation in terms of the original Reynolds number is useful primarily as a means of correlating calibration data; but then, when these data are to be used for problems in which the rate of flow enters as an unknown, some method of presenting coefficient data such as that indicated by Mr. Goodman is most certainly in order, as a matter of usefulness and common sense. You and Mr. Goodman are to be complimented on having made the material of this article generally available.—H. B. NOTTAGE, assistant project engineer, Pratt & Whitney Aircraft.

Fireplace Called an "Efficient Exhaust Fan"

THE EDITOR—

In the April HPAC, I noted a statement by E. P. Heckel on the Editor's Pages with reference to the use of a fireplace in an attempt to save fuel oil and his conclusion that its use increases rather than reduces oil consumption.

In the first place, I wish to state that I am not a heating engineer, except insofar as the information I have acquired by reading your magazine for several years, but I believe Mr. Heckel's statement should be qualified somewhat, although I would not question it for the particular case it is indicated he investigated.

In my home I feel that considerable oil was saved by the use of the fireplace, although I am ready to agree with Mr. Heckel that the ordinary fireplace is a fairly efficient "exhaust fan" and we all know that as a heating unit it is very inefficient. Nevertheless, I think that Mr. Heckel will concede that as long as the fireplace is in operation, heat is discharged into the room rather than being drawn out of it.

In my case, one-fifth of the 1942-43 heating season was over before I obtained a blank to fill out for oil rationing. We spent a good many uncomfortable evenings during this period trying to conserve oil because we did not know what our allowance would be. After we obtained our ration coupons and knew that our cut under the preceding year's consumption amounted to 27 per cent, we were able to determine upon a program that would enable us to live in comfort and still not use more than our allotment of fuel oil.

We used the fireplace almost constantly during the cold weather, burning wood that was purchased for the purpose and, in our case, I feel confident that the use of the fireplace did decrease our oil consumption.

Our fireplace is on the north side of the living room and the thermostat is on the west side, a considerable distance from the fireplace. My observation is that with a reasonable fire in the fireplace, the oil furnace would not cut in nearly as often as it would without the fireplace in operation. We got through the winter very nicely by setting the thermostat at 70 F for day and evening use and using the night control at 50 F from approximately

10 p.m. until 6 a.m. Naturally, it was necessary for us to keep some rooms closed off entirely and one of the two bedrooms closed off during the day in order to keep our oil consumption down to the proper limit. The other bedroom was heated constantly on account of its being occupied by a person 83 years old. The furnace is the usual type of oil furnace with forced warm air circulation.—R. C. FARIS, The Equitable Powder Mfg. Co.

THE EDITOR—

The comment from R. C. Faris is much appreciated. I am pleased to qualify my opinion and that of many others per the following:

A fireplace is primarily a single room heating unit, its heating effect being almost entirely dependent upon radiant heat emission. The cheerfulness and comfort to occupants produced by the burning fuel is generally accepted and not here contradicted. It is, nevertheless, a very inefficient method of heating when considered in relation to the negative effect it produces in other rooms and the rest of the house.

Invariably, the occupants of the room having a conventional type fireplace in operation are subjected to various cold drafts, emanating from the inward leakage of outside air around windows, down staircases, from the entrance hall, etc. That air motion represents the draft produced by air exhaust effect of the fireplace stack, and toward which the air is rushing. A certain volume of this air is necessary and is gainfully used to support combustion of the fuel, but much of it passes over and around the burning fuel only to escape with the smoke and flue gases, up the stack to the atmosphere. Thus, the normally experienced infiltration of outside air into the house is materially increased. This increase is in proportion to the fireplace and stack exhaust effect, which in turn varies with the type and kind of fuel burned and the rate of burning. Quick burning wood, which is most often used, requires considerably more air to support combustion than some of the other fuels, and obviously produces a greater air exhaust effect.

Of course, even though a fireplace is not in operation and the flue damper is tightly closed, we still can count on having some air infiltration. We try to hold this factor down to a minimum by weatherstripping of outside windows and doors, and calking of windows and door frames; and we do many other things which we hope will prevent or minimize the inward cold air leakage, mindful of the fact that it calls for energy that must be supplied in the form of heat after such air enters the house and which, obviously, affects the fuel consumption.

When a normal infiltration value is increased from, say, 100 cfm to from 500 to 600 cfm, as is frequently the case when a fireplace is put into operation in an average home, it very definitely effects an increase in fuel oil consumption because of that added heating load. An idea of what this added infiltration load represents may be shown as follows:

First, to heat the normal infiltration of air, estimated at approximately 100 cfm, from 0 F to 70 F room temperature, requires some 7500 Btu per hr.

Second, when a fireplace is in operation, the infiltration value is increased to approximately 500 cfm, under the same outside condition of 0 F. We may be content to let the rest of the house drop from 70 to 60 F temperature. The heating of 500 cfm from 0 to 60 F will demand some 32,000 Btu per hr.

The difference of some 24,500 Btu per hr represents the added heating load due only to the increased infiltration. Against this we could apply a slight credit due to the somewhat reduced transmission losses that theoretically would result from the reduced temperature difference between outside and inside conditions, with a drop in house temperature from 70 to 60 F. However, such credit would be insignificant and may be neglected here.

With fuel oil used of 140,000 Btu per gal heat value, and assuming a 70 per cent fuel burning efficiency, this added load represents an increase in oil consumption of 0.25 gal per hr for the conditions stated. Fortunately, we do not always have the stated extreme temperature difference requiring 0.25 gal per hr. However, if we consider a 30 F difference as more nearly a winter normal, instead of 60 F difference, the excess fuel consumption would be reduced to 0.125 gal per hr, still a sizable item.

Mindful of the fact that we all love a fireplace and to ask its discontinuance at any time would strike a discordant note, nevertheless it is my opinion that for economy of fuel oil, the operation of the conventional type fireplace is a snare and a delusion. — E. P. HECKEL, E. P. Heckel & Associates. Member of HPAC's board of consulting & contributing editors.

"Mr. Chairman"

Toward the end of every well-run engineering meeting, there is time set aside for questions and answers, and discussions from members of the audience. The editors of HPAC follow the same procedure in print; certain pages are regularly devoted to comment from readers on articles which have been published in our pages. Our readers are invited—in fact, they are requested—to discuss the articles or parts of articles which particularly interest them. Frequently, such comments are as widely read as the articles which inspired them. . . . HPAC's editors, our readers, and the authors of articles published in our pages, will welcome your views and opinions on the subjects treated each month. Address them to The Editor, Heating, Piping & Air Conditioning, 6 N. Michigan Ave., Chicago 2, Ill.

TEXAS PIPE LINE APPROVED

The War Production Board's approval of construction of a new pipe line from Midland to Corsicana, Texas, will provide a much-needed additional outlet for the oil of the rich West Texas-New Mexico Permian basin, "last known area in which U. S. crude oil production can be substantially increased," Petroleum Administrator for War Harold L. Ickes said last month.

The new pipe line will carry 42,000 barrels of crude oil daily from the Seminole and adjacent producing fields to connecting pipe lines that serve refineries on the Gulf coast.

EXPANDS

Narowetz Heating & Ventilating Co., one of the four "co-adventurers" on the big Dodge-Chicago Plant Division of Chrysler Corp. job, marked the 40th anniversary of the firm's founding by moving last month into expanded office facilities at 1722 Washington Blvd., Chicago.

AMERICAN SOCIETY of HEATING and VENTILATING ENGINEERS

Journal Section

1894 1944

A. J. Offner

ASHVE 50th Anniversary

THE FIFTIETH Annual Meeting of the ASHVE will be held at the Hotel Pennsylvania, New York, N. Y., January 31, February 1 and 2, 1944, and the Officers and Members of the New York Chapter want to extend a hearty welcome to their fellow members and invite all members of the Society to join in making this occasion an outstanding event and a fitting climax to 50 years of service.

The meeting theme will be The Past, The Present, The Future, and every technical session will have a paper of special significance according to plans being developed by the Meetings Committee. Watch for later announcements giving full details of the program.

R. H. Carpenter

J. C. Fitts

A GREAT PAST A GREATER FUTURE

W. E. Heibel

A. E. Stacey, Jr.

R. A. Wasson

C. S. Koehler

Thoughts of FIFTY YEARS 1894-1944

14 HEATING AND VENTILATION. October 15, 1894.

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SUGGESTIONS for the advancement of the American Society of Heating and Ventilating Engineers, such as are given in this issue, cannot fail to be of interest, as they indicate the directions in which the greatest development may be expected. The society is now in working order, and many applications for membership are being received. At present there are eighty charter members, all of whom are deeply interested in the success of the new movement for which they are earnestly working. The secretary, to whom all communications and applications for membership should be directed, should be addressed at Room 146, World Building New York.

THAT there is this increased efficiency in the ventilation can be readily shown, and the idea is of interest and value to the fitter, says a heating engineer. The reasons are plain, readily grasped. The explanation rests on recognized as one of the laws of heat, to the two bodies of different temperatures be put in contact, heat will pass from the warmer body until each time as an equilibrium is established, and both bodies represent an The amount of heat thus passing will be the greater, the greater the difference between the bodies.

THE reaction in which low also an argument in favor. There can be no question b in a room for placing direct windows on the exposure current of cold air bel

stricken where it can meet this air current before it g into the circulation of the room gives an opportunity checking the current, which would otherwise pass d ward constantly, maintaining a flow of cool air o floor, and forming a consequent source of annoy discomfort.

THE MAIN argument, of course, against th heated use of low radiators is their cost, of fact the increase in efficiency keeps p with the increased cost, and then tends to equally expensive. In most instances, little question but that low radiator make a much more presentable appea any other arrangement of direct-ho with an understanding of their consequent lowering of price, g general introduction.

SPEAKING of the time to porary says that it should t tution comes to multiply on after you and have m when you have conv gle with yours that than he or she can it to be the rule strip heating thou when men stop through the d forget the v business ir perity; w thorough last ye exam post cor

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THE AMERICAN SOCIETY OF HEATING AND VENTILATING ENGINEERS.

Suggestions for its Advancement.

[Believing that suggestions as to the best methods of insuring the or...ess of the American Society of Heating and Ventilating Engineers would be of interest, we have written to its members for an expression of their views on the subject. The benefits to be derived from membership in the new society will be greatly enhanced by the individual interest taken in its progress, and it gives us pleasure to publish some ideas which it is thought will best secure its advancement.—Eds.]

From John A. Payne, Capitol Heating Co., Providence, R. I.:

In reply to your question "How can the American Society of Heating and Ventilating Engineers best benefit its members?" I would offer the following five suggestions, namely, in its admission of members; by using every means within its power to increase their practical and scientific knowledge of heating and ventilation; by using its best endeavors to eliminate competition; by encouraging and fostering their social and professional intercourse; by keeping in touch with its most distant members by the medium of the seven first-class publications; by keeping their interests alive by means of a yearly meeting and by the publication of papers, etc., read before the society.

From A. C. Edgar, Model Heating Co., Philadelphia, Pa.:

The American Society of Heating and Ventilating Engineers can best benefit its members by establishing a closely defined code of standard of heating and ventilation for all classes of buildings.

From H. J. Barnes, Barnes Steam Heating Co., New York:

I think the new American Society of Heating and Ventilating Engineers will exercise an excellent influence in our field of effort in many ways. They will be teaching their plans and specifications on plain and comprehensive that the contractor can figure to a fair profit on the work intended for. The second will be to insist that every building that enters under their supervision shall be properly ventilated as well as heated, if the engineer is convinced and satisfied of it, he will insist and agitate until, and a little while he will have his way. The third will be the interchange of knowledge of the different members of the society, which will be very beneficial to them all. The consulting engineer will come in contact with the manufacturing engineer, and all will receive pleasure from an interchange of views. The eighth paragraph of Sec. 6, Art. I. of the Constitution defines the advantages of the society to the public and to its members, but the benefits they may handle that can not be strictly defined. I remember a great many years ago a so-called committee of one would go to the steam heating contractor and get him to make his plans and specifications. The committee of one would be paid by his client and also by the contractor who got the work. It is needless to say that the fact of being a member of real heating and ventilating engineers will put a stop to anything of that kind. There are a great many things, some of them harmless, others real evils, that a society of this character puts a quietus on at once for it has behind it the force of numbers. In relation to its money to society, to the whole world, perfect heating and ventilation. While it cannot reach the high aim, it can approach it, and while it cannot change human nature, its tendency will be to establish a high ethical standard among its members, so that the fact of work having in charge of one of its members will be a guarantee of excellence and of everything that will make honest workmanship. It will be the repository for all learning, for all knowledge, in its own especial field, and will be looked upon throughout the world who are interested in heating and ventilating plants as standard. The arrangement of seasons, conventions, and meetings where every one who is interested in its objects an opportunity to participate to its benefits.

From Chas. H. Orndorff, Heating and Ventilating Co., Philadelphia, Pa.:

I have received your respected favor of recent date in which you ask my views as to how the American Society of Heating and Ventilating Engineers can best benefit its members. Without giving the matter the serious thought that such an inquiry deserves I could briefly state the salient points that occur to me at the writing. The benefits to be derived are as unlimited as they are great. I would be impolitic to treat of but a few of them, but the more important points can only be briefly mentioned.

It is at once apparent that the greatest benefit to be derived will be the collaboration of thought and the inter-communication of ideas that thought shall by discussion and comparison be developed in the form of a report. It will be entirely necessary, however, that all business benefits should be eschewed from these meetings, and that the idea of each member should be to impart to his fellow members any information relative to heating and ventilating subjects which he thinks his fellow member is not possessed of. It does not matter how great a man's ability is, he can always be brought to a lower light, and this constant interchange of thought will tend toward the triumph of the art of heating and ventilation.

I should appear to me, without making any suggestion as to the routine of management of the affairs of the association, that there should be certain times established, either quarterly, semi-annually, or annually, but a convention to be held at some figure to be determined upon by the will of the members, and at this convention papers should be read on matters germane to heating and ventilating, which would be for discussion and the final adding out of important facts.

I also think that there should be appointed a correspondent to whom all the members could refer upon the various subjects on which they need light, and this correspondent, being familiar with all the members and papers can apply the information to each other member as he knows can give it, and he in turn can transmit it to the inquirer.

I also think it highly essential that some journal, not your own valued paper, should be selected by the society as their medium, which the members can publish from time to time their ideas, or make inquiries, and can announce to the fraternity at large any peculiar result or effect that they have met under terms forcing their professional calling.

It is also to be assumed, hoped that none of the members of the society, who may engage at the same time as contractors, will be debarred from the fraternity at large any desirable information which they may possess, and which may be of advantage to the society.

If the society is carried on in this liberal, open handed manner, it cannot but result in advantage to us, as heating and ventilating engineers, and to the community at large. As before stated, there are several ideas that occur to me hastily, without giving the matter serious consideration.

From John Gerrely, expert, 1,432 Lombard avenue, Philadelphia:

I think our first effort should be to establish a standard of value for our services upon which each member should be pleased to try and collect. It would be an interesting study to determine what attraction lends the most generous returns of our best into the steam heating trade, or why less generous ones are so entering our profession, as quick as formed into models of self-advertising remarks. It would appear certain that there are in the business, for does not the engineer owe it as much to offer a remuneration for services as one professional? Yet when spending services by an architect or engineer would only be sought to suppress. How many individuals are to lay out a steam job, make a set of specifications and estimate of cost, expect as a matter of course you that I must pay for it? How often has each member of each society been asked to bid on work, making his own specifications, when he was morally certain from six to twenty months' training likewise, with a knowledge that but one could win and he had their labor of love for nothing? Is that right? Would the owner have to more than three bids if he were required to pay for value received? Have you ever spent days perusing the contract and specifications and found after work the owner was "changing you" and stealing intended to give the specifications to others? We should arrange matters so that those who spent time interpreted it in operation should pay for the same. It is time for us to place our business on a basis satisfactory, and establish such methods as we should? Why should we not have manufacturers who advertise to send a heating engineer, her and pay their own traveling and board while there, and do all for nothing, receiving their bodies but not their souls? Shall we not our profession into the gutter, and to compete with the lowest bidder? Where will be our skill and intelligence as the physician or lawyer services for which they would make fifty dollars or charge nothing for? Is not heating processes let as he just to contractor if he set no price value upon our services both can we expect success?

Another point of advantage to us as a society would be to have a new card with the name and address of each member on each envelope's name and address, and the address of the merchants in the principal cities, and seat yearly, as the manufacturers changes in heads, withdrawal, or additions occur. For our own advertisement have a certificate of membership, framed, hung conspicuously, to let the world know "we are in it" for business and please, and are proud of it.

From B. Harrold Carpenter, N.C. Carpenter & Co., Wilkesbarre, Pa.:

In reply to your question, how can the American Society of Heating and Ventilating Engineers best benefit its members, I would say, generally speaking, by encouraging the subject of heating and ventilation before the public at large so directly as to

create a demand, not for cheaper but for better heating and ventilation; and also by bringing to as near upon the members the necessity of a higher grade of work as to cause them to strive to excel, not to meet it as now, in a question of price, but as to the best result.

I would favor legislation compelling a certain amount of ventilation in all public buildings, the amount to be fixed according to the number and purpose of the building. Also, would not a public inspector, to whom all plans should be submitted, be a benefit?

The idea is prevalent with many that competition is the final refinement of the immutable contract and that any restriction of competition is a crime. The nineteenth century is rapidly drawing to a close, and with the advent of the twentieth century would it not be a glorious attainment if the American Society of Heating and Ventilating Engineers could change the demand for cheap heating and ventilating systems to a demand for the best systems?

From Thomas Berwick, Arlington, N. J.:

Your inquiry "How can the American Society of Heating and Ventilating Engineers best benefit its members?" elicits the answer, By benefiting the public in general.

First—By adopting a standard of temperature for heating various types of buildings that shall be acceptable to heating engineers and the architects and the public.

Second—By the adoption and demand of better ventilation among the tenements of our large cities, so that the general health of the parish shall be benefited, as saving prevention as far as possible, of contagious diseases.

Third—By the adoption of a standard of ventilation for various types of buildings, and the agitation of the question among all classes of men, to the end that it will be demanded in future construction of buildings.

Fourth—The enforcement of wise laws in regard to the ventilation recorded in buildings, theaters, assembly halls, etc.

Fifth—The co-operation of all heating and ventilating engineers in carrying out the above suggestions.

Sixth—Increasing the membership of the society, by the addition of members of the professions who make studies of the various branches, and the burning of the question in the various large cities to have informal meetings, at which discussion shall be free upon all topics relative to the public welfare in connection with heating and ventilating. We must make ourselves interesting to the public, and the public will become interested in us, and the members of the American Society of Heating and Ventilating Engineers will become one of the forces of the times, benefiting themselves by increasing others. Assisting in improving the health of the community, they will reap the harvest of wealth from the general economy.

From J. D. Hibbard, The John Davis Co., Chicago, Ill.:

I would say I do not know that my views in regard to the purposes of the American Society of Heating and Ventilating Engineers, given in an off-hand manner, would be of any particular benefit to the society. At the same time, I would say that I am very glad that such an association has been organized, and hope that it may be capable of a great deal of value, both to its members and to the profession at large, and I shall be glad at any time to do what little I can to this end.

From F. R. Kidder, 249 Water street, New York:

In reply to your inquiry as to how the American Society of Heating and Ventilating Engineers can best benefit its members, I will say that in my opinion, Mr. Smith, in his address to the Detroit convention in September 1893, gave thoroughly covered the ground. If these principles are carried out, the best result is much good not only to the members of the society, but to the public, or that portion of it which may become patrons of its members. A free interchange of opinions on different points is what is necessary for the highest class of work. The engineer exploring these systems and discussions on public lines brought before him, no doubt, much to benefit himself with, no doubt, much to benefit the public. The time fixed for these discussions should be compiled from as many actual cases as possible. This would then allow work to be selected as a basis for the contract plan, thus doing away with much of the guesswork, which, to no doubt does at the present time, with the exception of plenty of opinions among heating engineers.

From J. S. Kinsely, Washington University, St. Louis, Mo.:

In reply to your inquiry I will say that it seems to me that the interests of the members of the American Society of Heating and Ventilating Engineers will be best promoted by encouraging the writing and publication of the papers in its meetings, of papers on subjects pertaining to heating and ventilation, and the publication and discussion of the papers in the regular publications of the society. Members engaged in contracting or commercial practice have seldom the desire or time to write long treatises on any subject, but are usually glad to give to the profession and the world the results of their experience, interested in the subject discussed. These short papers often contain the most valuable information, and they, with the results of scientific investigations, would form the base of all books on the subject, and are reserved to be those who collect the knowledge/present of the subject and put it in convenient book form.

It is especially important, therefore, that the society should be encouraged to get its knowledge where it may be used by all the others, and the most important work of the society, in my opinion, is the collecting of individual knowledge and putting it on record for the use of all.

From Percival H. Seward, American Radiator Co., New York:

I would say that in my opinion the American Society of Heating and Ventilating Engineers can best benefit its members greatly by securing to them more opportunities to get together and discuss, or have discussed, the various problems which are continually being met by them in the practice of their profession. The object of this society, as I understand it, is to advance the science of heating and ventilation, and in order to bring the best engineers practicing the profession to a higher level than it has attained in the past, I think that the subject is a proper one, and one that ought to appeal to all members. We all of us admit that there is not sufficient reliable data at hand from which to formulate practical details, and any means by which we are enabled to deal more closely with experimental data, in my opinion, ought to be encouraged.

Every individual has his own things in regard to which he has formed opinions, but few can turn their ideas to really practical use. I think it would be advantageous if the society could arrange so that the men get their pre most familiar with and thing from before the society at its meetings, and also distribute the papers to all members, by the action we would get an exchange of opinions which is really the most rapid route to increasing knowledge. Only people who have studied a question in the privacy of their own office can fully appreciate the difficulties, and effort to aid anything, and if we can get the money together sufficient exercises to bring the leaders and most progressive minds of their profession, and the results of experiment, I think all will receive great benefit from the meetings.

Apart from the reading of papers, I think the society can be of great service and benefit to its members by the discussion of different ideas and practical methods of different engineers, and I think that we can promote the object of the society by encouraging heating and ventilating engineers that they are not necessarily competitors, but that the interest of each one of them is identical with that of the other, and that they ought to be drawn closer together.

all brought to the attention of members through monthly reports issued by the association, fearful, if ever, some of the interchange of views and experiences and thoughts here exchanged, would be lost. These associations promulgate a feeling of perfect freedom in meeting and exchanging ideas, in doubt on a subject, to the end that the science of heating and ventilation will reach that standard it should in the construction of our homes and public buildings, and to be a member of the American Society of Heating and Ventilating Engineers will be a sufficient guarantee that this branch of the work will receive proper attention.

From H. S. Prather, 203 Carolina street, Buffalo, N. Y.:

The American Society of Heating and Ventilating Engineers has started out under most favorable auspices, at a time when the subject of heating and ventilation is in conjunction with heating is coming rapidly to the front in the considerations of engineers, architects, and the public at large, and at the time when the undertaking of the construction of large numbers of public buildings all over the country is creating a demand for the best systems and appliances that the ordinarily well posted to appreciate the discussions which will come up and are to have the society's interests at heart.

We want to forget any division that the society is to be used for partisan or personal interests.

Such a society as we have formed ought to be capable of maintaining a point of reference for engineers, where all the latest papers, books, and magazines pertaining to the profession can be found, and where members can drop in and discuss things of interest from time to time. The most convenient location for this would be in New York city, as we will find the greatest number of visiting members and greatest number of engineers.

The reader should have all the time if desired, so that local members could drop in whenever they were able, and where visiting members could be sure of meeting some of the local engineers from time to time. A considerable of how the older engineering societies have got along would seem to also a safe guide for the new society. It would seem to the writer that this subject may be briefly developed in the following manner, as follows:

1. By valuable and instructive papers on certain topics, on the various branches of the business and resources of the members, on topics having a general lesson with conclusions, efforts and results, and theories of the experts. These descriptions and records of the experiments, the successes and the failures, new ideas and schemes of the members with their wealth of valuable data, will prove a great benefit to all of the members, but to the shape of volumes of the transactions of the society will become valuable additions to their libraries of reference.

2. By the cultivation of a higher general standard of membership, by which the most selfish and of personal courtesy in business intercourse. Surely there is a field for cultivation of this kind. Even the "standard of requirements" should not be simply a plant that "grows" in on the specified conditions, but it does not seem required under a favorable test, but such a standard that the highest efficiency possible in the engineering profession is always aimed at, this practically covers also the standard of moral responsibility. It should be the object of the whole society of the society, of its papers, its rules, and its formulations, to inculcate such a standard of requirements and moral responsibility that the name of the society and its members will have the definition of a guarantee with first-class work and, the highest integrity. This brings up the point of personal courtesy in business intercourse. Any member who has been "on the road" can attest the need for reform in this line. A brusque and over generous feeling should prevail. Tricky specifications with vague clauses and unfair statements may get a desired amount of business, but they never pay in the long run, and never characterize real and upright engineering, and ought not to exist in this. I have had experience exploding these systems of heating and ventilation in public and school buildings, and, not satisfied with the results, planned by them apparently, they have also exploded him personally. This is truly economical, as it caught out the fakirs, but they lost his own time, and inconvenience, but a perfect right to them.

The object to learn to attack the ideas themselves and not the individuals that advance them.

It is certainly, and unquestionably, and I think that if the members of this society, will be brought more in contact with each other and have their views and others' ideas freely discussed and criticised from a purely professional standpoint, a great object will have been accomplished.

I believe the society can be of much benefit to its members by keeping an exchange as possible.

I do not mean that to be eligible for membership one must know all that is to be known about the particular branch of engineering, as there is no use of calling together when the house is closed, but let each three individuals become members who are actually engaged in the business, and who are sufficiently

Less Fuel vs. Comfort

By M. F. Blankin, President
American Society of Heating & Ventilating Engineers

UNDER PRESENT conditions it is necessary to make every owner and operator of a heating plant conscious of the need of fuel conservation and every heating engineer should enlist in the current campaign to advise people how they can be as comfortable as possible as we enter the next heating season.

CONSERVATION PROGRAM ANNOUNCED

The United States Government is sponsoring a broad program to save such critical resources as manpower, materials, equipment, and fuels through conservation of coal, petroleum products, electricity, gas, water, communications, and transportation.

This program, which will start about September 15, calls for voluntary action by the public and by industry to make important savings in the domestic and commercial use of these critical resources. It has the support of the War Production Board, Solid Fuels Administration, the Office of Defense Transportation, Petroleum Administration for War, and the Office of War Information, and is being carried forward by all the industries concerned.

With the war approaching a decisive stage, the need for conservation has become more urgent than ever before. A comprehensive program of information linking all phases together will be carried on by the government, and the industries themselves will conduct national and local campaigns explaining in detail exactly what each individual can do to conserve critical resources.

Donald M. Nelson, Chairman
War Production Board

Harold L. Ickes
Solid Fuels Administrator for War and
Petroleum Administrator for War

Joseph B. Eastman, Director
Office of Defense Transportation

September 11, 1943

It is possible to release hundreds of thousands of railroad cars and trucks now transporting fuel, for other services, if the cooperation and interest of every fuel user in eliminating waste, can be obtained. Actually by making a saving of only 3 per cent of all the coal used for heating purposes we will need *108,000 carloads less.*

Throughout the summer, government sponsored campaigns in the press and over the radio have urged (1) "Order Coal now"; (2) "Order Fuel Oil Today"; (3) "Winter Proof Your Home." Conservation is the order today and a program to save such critical resources as fuel, is now under way and public attention will be focused on this matter throughout the month of October.

The Society's War Service Committee has already urged Society members to support the government's Fuel Conservation Programs to the fullest extent and has suggested to ASHVE members that they tell how "an important amount of fuel can be saved by increasing the efficiency of the boiler or furnace as a heat conversion plant and by increasing the efficiency of the building as a structure that will retain the heat supplied to it."

For the present heating season estimates of the fuel supply indicate that less oil and coal will be available, therefore, the problem of generating and utilizing the heat must be accomplished with the greatest efficiency in order to obtain reasonable comfort.

It may be a surprise to learn that fuels used for residential heating purposes rank according to their importance in the United States: Bituminous coal 36.85 per cent; Wood 22.73 per cent; Anthracite 13.43 per cent; Gas 11.32 per cent; Fuel Oil 10.05 per cent; Coke 4.47 per cent and all others 1.15 per cent.

In the six New England States fuel oil is first, with wood second; in the three Middle Atlantic States anthracite is first; and in nine

Folks We All Know...
...BUT FAILS TO REALLY HELP HIS COUNTRY BY HEEDING ITS WARNING TO
ORDER OIL TODAY!
OFFICE OF WAR INFORMATION

South Atlantic States wood is first in four states, anthracite in two states and bituminous in three states; in the North Central States bituminous coal is first in 12 states and in eight South Central States wood is first in six states, bituminous coal in two and gas in one; in the Mountain States bituminous coal is first in six states and wood in two, while on the Pacific Coast gas and wood are first, according to figures compiled in 1940 by the Fuel and Utilities Branch of the Office of Civilian Supply.

The real enemies of fuel conservation and comfort are (1) low heating plant efficiency, (2) improper operation, and (3) poor building construction. The farsighted owner has taken steps to correct some of these conditions during the summer, when the heating plant was shut down, but constant attention to improving the operating efficiency and keeping it at the peak is equally important during the heating season.

An efficient responsive heat generator in the basement is, of course, extremely important—and it should be kept in good condition so that it will last a long time and so that it will perform with the highest efficiency of which it is capable. It should be connected to a chimney of adequate size and height, which will handle the volume of gases leaving the boiler or furnace, and will provide draft of sufficient intensity to draw the gases of combustion into the chimney overcoming the resistance of the heating unit and the fuel bed.

It should be examined before anything else is done and together with the connections from the heating unit, should be put in first class condition. Without an adequate chimney, particularly when burning solid fuel, coal will be lost through excessive shaking of grates in attempting to get the fuel to burn, and the fire will in general be unresponsive to the damper controls. Have the chimney fixed to save fuel!

In certain cases heating surface can very readily be added to the boiler in the form of "pancake sections." This applies chiefly to round boilers that are assembled with less than three sections above the fire-pot. The saving in fuel made by adding heating surface will yield dividends every year in the future.

Attention should also be given to the possibility of reducing the heat loss from the boiler or furnace. The heat loss may amount to only a few per cent when the appliance is operating at rated output, but may be large, for instance, in uninsulated steam boilers when operating at low rates. A good rule is that the insulation should at least be equivalent to 1½ inch of asbestos.

Warped, cracked, or loose clean-out doors are a source of heat loss. Sometimes rust accumulations on door frames or on door surfaces prevent proper closing. Cold air leaking into flues cools the gases of combustion and carries heat out through the chimney.

Ashpit doors and ashpit dampers should be tight when closed in order to obtain good control of the fire when burning solid fuel. It is well worth while to close all openings through which air can leak into the ashpit; in order that the inlet air and fire may be properly controlled by the draft door or damper.

Damper controls and regulators which operate dampers are very effective fuel savers. They should be in adjustment and be connected by the proper length of damper rods. Many owners fail to take advantage of the controls with which the heating unit is already equipped.

The value of clean heating surface is freely admitted, but few owners take the trouble to clean the flues unless the boiler begins to smoke through the fire door. It is a good rule to inspect the flues periodically at intervals depending on the type of fuel being burned and to brush or scrape the surfaces clean when necessary.

With reference to ashpits in appliances burning solid fuel, it is important that ashes should never be allowed to accumulate under the grate to the extent which might prevent air from reaching the grates. Grates are "air cooled," and if the air from the ashpit cannot reach all parts of the grates, they will burn out, warp, or grow in length.

Periodic inspection of the heating apparatus should include an inspection of motors, blowers, controls and other moving parts to determine whether lubrication or adjustment is necessary. Mid winter repairs are always inconvenient and bring discomfort.

All steam and hot water heating plants should be carefully checked and placed in the most efficient operating condition. Where possible steam plants may be modernized by installation of new radiator air valves and main vents, repacking radiator valves to prevent steam leaks. Vacuum vents on hand-fired installations will save fuel. Safety valves should be checked, water feeders should be overhauled or installed if lacking because protection of existing equipment is as important as fuel saving. On larger systems traps should be checked and leaking ones repaired, pumps overhauled or installed so that all water of condensation will be returned to the boiler. Many systems are operating today using 100 per cent make-up water.

Hot water systems can also be completely modernized; a circulator will often convert a sluggish circulating system into an efficient one. The safety valve and expansion tank should be checked and placed in safe operating condition. Where a system is automatically fired the boiler limit control should be set at the lowest temperature consistent with the design temperature or the Btu heat emission rate.

During the past heating season solid fuel has not always been available in the size to which the owner has become accustomed. This has been true particularly in anthracite burning areas where many customers have been asked to substitute a different size of anthracite or coke in place of the size which they have been using for years. With proper instruction on method of handling the fire, substitution can usually be made successfully. A change to smaller size of anthracite will require that more draft be provided (in other words, the dampers should be set to obtain more draft over the fuel and to admit more air into the ashpit).

The furnace grate area and the depth to which the coal is fired are the two governing factors in the selection of size of coal. Consult the directions provided by the

manufacturer of the boiler or furnace, or your coal dealer for the proper size and kind of fuel to be used. Do not wet the coal before burning it. Garbage or rubbish should not be burned in the heating system.

Leave from two to three inches of ashes on the grate at all times for protection against excessive heat and to prevent unburned coal falling through. Coal should be heaped as much as possible against the rear or side walls of the firebox so that a portion of the glowing fuel is always left exposed to ignite the gases. Keep the firebox filled to a level with the bottom of the firing door. Avoid poking or punching holes in the fire.

After fire is started the damper in the smoke pipe should be partly closed, depending on draft conditions. Control the fire with the check damper in the smoke pipe and the ashpit damper. For moderate heating requirements, open check damper wide and close ashpit damper. As additional heat is required close check damper partially or fully and open ashpit damper similarly. The damper in the fire door should be slightly open at all times. Do not leave fire door open as this wastes coal. The ashpit doors and draft slide should fit tightly.

Do not shake the fire unnecessarily. Stop shaking when the first red glow appears in the ashpit.

For the proper operation of an automatic coal stoker, oil burning unit, or gas-fired plant, follow the detailed directions of the manufacturer or utility.

In Bulletin 20 entitled, Conservation of Fuel, by Rowley, Jordan and Lund, just published by the Engineering Experiment Station, University of Minnesota, a Summary of Fuel Conservation Methods is given which can be used profitably by the owner and operator of a heating plant and is quoted as follows:

FUEL CONSERVATION METHODS

I.—Insulation of Walls and Ceilings

1. Application of insulation to the ceiling of the top floor will save from 10 to 20 per cent of the yearly fuel costs.

2. Application of insulation to walls of a residence will save from 10 to 20 per cent of the yearly fuel cost.

3. Application of insulation to walls and top floor ceilings will result in an increase in the inside wall and ceiling surface temperatures. This will result in increased comfort and decreased fuel costs.

II.—Storm Windows and Storm Doors

4. Application of storm windows and storm doors will result in a fuel saving of 10 to 25 per cent.

5. Application of storm windows will raise the inside window surface temperature and thus result in increased comfort and increased fuel savings.

6. Application of storm windows will permit the maintenance of higher relative humidities inside the structure without condensation of moisture and formation of frost on window surfaces.

III—Air Leakage

7. The installation of weatherstripping to doors and windows will result in fuel savings of 5 to 10 per cent.

8. All windows and doors should be kept closed except to maintain a minimum of ventilation.

9. If heat is reduced or shut off entirely from bedrooms, storage rooms, etc., door cracks, leading to these rooms should be plugged in order to prevent drafts of cold air from entering the remainder of the house.

10. All fireplace dampers should be tight fitting and maintained closed during the heating season except when in use.

11. All doors leading from heated portions of the house to unheated attic spaces should be well sealed to prevent leakage of cold air.

12. Over a period of years there may be a separation of the window and door frames from the exterior building materials because of continual expansion and contraction of these frames and materials when subjected to varying temperatures. Air leakage through such cracks may be largely eliminated by filling, or, as is commonly termed, "calking" these cracks and crevices.

13. Air leakage through cracks between the upper and lower sashes of a window may be eliminated by the application of a piece of cellulose tape to joints.

14. The air leakage into basement areas should be reduced to a minimum so that the heat escaping from the heating plant is put to good usage in eliminating cold floors above the basement. All broken basement windows should be repaired and all cracks should be well calked.

IV—Steam and Hot Water Heating Systems

15. For highest efficiency all steam and hot water piping should be quickly freed of air during operation and completely filled with steam or hot water.

COAL USERS, ATTENTION

Harold L. Ickes, Solid Fuels Administrator, declared on September 18 that every coal consumer in the United States will find it necessary to cut his usual fuel consumption during the forthcoming season to insure enough coal for war industries, to avoid personal discomfort from lack of heat during the winter, and to provide for possible shipments to the Army in liberated territory.

There are many definite ways by which coal can be saved, Mr. Ickes said, and if every consumer will constitute himself a conservation committee of one we may have enough coal to operate all our plants, send what is needed to our armies in conquered lands, and at the same time avoid any actual distress in our homes and schools and churches because of lack of coal.

Conservation, however, cannot be limited merely to saving coal used in domestic heating, the Administrator said, indicating that saving must be effected all along the line —by the railroads, power plants, and miscellaneous industries.

16. Any steam or hot water pipes which are not actually used to aid in heating rooms should be well insulated.

17. Any radiators which are not in use either should be covered or the lines leading to them should be disconnected.

18. Any objects which shield radiators such as drapes and curtains, magazines, cabinets, etc., should be removed in order to obtain the maximum output from the radiators.

19. Any collection of dirt between the sections or fins of radiators or convectors should be removed to obtain maximum radiator efficiency.

20. For maximum efficiency, radiators should not be covered with a coating of bronze or aluminum paint. The radiator efficiency may be improved as much as 10 per cent by the application of ordinary oil paints, preferably of a dark color.

21. Some fuel saving may result and some increase in radiator efficiency may be experienced if a surface of high reflectivity is placed behind each radiator. Much of the heat which normally would be absorbed by the surface of the wall back of the radiator would then be reflected into the room.

22. If a forced circulation hot water heating system is used, the motor bearings of the water pump should be oiled at least once each season.

23. Any insulation missing from the boiler covering should be replaced to reduce the loss of heat from the boiler to the basement.

24. All flue surfaces should be cleaned periodically, preferably with wire brushes and a vacuum cleaner. Collections of soot on the flue surfaces may reduce the efficiency of the heating plant as much as 5 per cent.

V—Warm Air Heating Systems

25. The air filters of a forced air heating system should be either cleaned or replaced at least once each year or more often if necessary.

26. With both gravity and forced air heating systems all the joints in both the supply and return air ducts should be sealed with strips of asbestos or made tight in some other approved fashion. However, the entire duct work should not be covered with a layer of asbestos paper as the change in color and nature of the surface when covered with paper will increase instead of decrease the loss of heat from the ducts.

27. All supply and return air registers and grilles in both gravity warm air and forced air heating systems should be open and unobstructed. In no case, should furniture, rugs, or other articles be allowed to prevent the free flow of air through these openings.

28. With a forced air heating system, additional heat is required if outdoor ventilation air is taken into the unit and distributed throughout the house. The most economical operation of the heating plant will be obtained when the introduction of outdoor air is entirely eliminated and all air passing through the heating unit is 100 per cent recirculated from the room.

29. In gravity warm air heating systems all return air ducts should be insulated from any high temperature source of heat. If this is not done, the air returning to the furnace will be heated before reaching the furnace and this will reduce the ability of the system to circulate air by gravity.

30. If a cast iron furnace is used in conjunction with a gravity warm air heating system, the joints between the castings of the furnace should be reset and recemented every three or four years by a reputable heating contractor.

31. The motor and blower bearings of a forced air heating system should be oiled at least once each heating season.

32. The flues and heating surfaces of any air heating system should be cleaned of all soot periodically to maintain highest efficiency. A deposit of soot on such heating surfaces may reduce the overall efficiency of the heating plant as much as 5 per cent.

VI—Domestic Hot Water

33. A hot water storage tank should be thoroughly insulated to reduce the loss of heat from the hot water in the tank to the surrounding air.

34. All leaky hot water faucets should be repaired to eliminate this waste of both water and heat.

35. If it is found necessary to allow water to run during cold weather to prevent freezing of piping, this defect in the piping system should be repaired. The application of insulation at the correct points will usually eliminate the necessity of running the water.

36. The amount of fuel required for heating domestic hot water may be reduced by heating only during morning and evening hours and never heating water above a temperature of 140 F.

VII—Maintenance of Correct Temperature Within the Heated Structure

37. Appreciable savings in fuel may be effected by the maintenance of the lowest practical temperatures within the heated structure. It is usually possible to maintain much lower temperatures during the night time hours than during the day time hours to effect even further savings.

38. Reduce or turn off completely all heat supplied to unoccupied spaces. If there is any danger of damage by freezing in such cases, maintain the temperature slightly above freezing at all times. In the case of radiators in unoccupied spaces, the simplest means of shutting them off without causing damage to the radiators or the piping is to cover them.

39. If a structure is to be unoccupied for several days, the temperature may be reduced to 45 or 50 F. It should be kept in mind that if the temperature is reduced much lower than this, there may be some damage by freezing of pipes in walls or of plumbing because the temperatures to which such pipes are exposed would be somewhere between the indoor temperature and the outdoor temperature.

40. Install thermostatic control, if possible, to prevent overheating and a consequent waste of fuel.

VIII—Combustion Efficiency

41. If automatic fuel is being used in the heating installation, the percentage of carbon dioxide in the flue gases should be checked by a reputable heating contractor in order to ascertain whether the fuel is being fired with maximum efficiency. In addition, the chimney draft and the stack temperature should also be checked. For best results, all of these determinations should be made by instruments as it is virtually impossible to determine the correct setting for firing a fuel by any other means.

42. All heating installations firing automatic fuel should be equipped with automatic draft regulators in the stack for maximum efficiency. Without such a device it is impossible to set any installation for maximum efficiency under all conditions as the stack draft will vary considerably with changes in outdoor temperature and wind velocity.

43. The fuel input to an automatic heating installation should be adjusted to the lowest practical value which will satisfy the heating requirements during the coldest weather conditions.

44. If the heating surface of a boiler or furnace is insufficient to satisfy the maximum heating requirements and still maintain reasonable efficiency, it may be possible to increase the heating efficiency of the installation by the use of a fuel saver.

45. If hand-firing of coal is used in the heating installation, care should be taken that the methods of firing are those which will result in a minimum waste of fuel.

IX—General

46. A minimum loss of heat through windows will result if all shades and drapes are fully drawn during the evening and night hours and if the shades are half drawn during the day hours. Drawing of shades and curtains will not only result in a reduction in heat loss through the windows but will also raise the average surface temperature of the room and thus result in a greater feeling of warmth to the occupants for the same temperature conditions within the room.

47. A considerable saving of fuel may result if all windows are kept closed during the night hours. From the standpoint of actual ventilation requirements, there is sufficient leakage of air from the outside of the house to the inside of the house to take care of any needs from a health standpoint. The necessity of opening windows in bedrooms during night hours is principally psychological. The only time when opening of windows in a residence during winter months is truly justified is for the elimination of odors.

48. Some rooms which are heated during normal times and which have very high heat losses may have the heat cut off for the duration of the war without any undue discomfort. For example, heated garages are a luxury, as the amount of fuel required to heat the average garage, even when attached to the house, is great in comparison with the advantages gained. Sunrooms are also usually very difficult to heat because of the excessive glass areas. The heat supplied to such rooms may often be entirely disconnected or greatly reduced without any undue discomfort.

From all of the evidence available it is clear that large quantities of fuel can be saved during the coming winter, and it is the patriotic duty of every Society member to render outstanding public service in his community by advocating fuel conservation in both the industrial and residential fields.

ASHVE Sponsors Fuel Conservation Program

A proposal has been made to all Local Chapters of the Society that October Meetings be devoted to a discussion of Fuel Conservation and in a President's Memorandum to Chapter Officers it was suggested that a program be prepared which would deal mainly with the proper functioning of the heating plant, because it consumes the fuel and its efficiency is of paramount importance in fuel saving.

This fact will be apparent when it is realized that 28 per cent of the dwelling units in the United States were built prior to 1899, 38 per cent during the period 1900 to 1919; 25 per cent between 1920 and 1929, and 7 per cent between 1930 and 1940.

Fuel must be saved this year and if the efforts of Society members can be instrumental in having people act to correct the various faults in their heating systems and take all necessary steps to reduce heat losses by the use of storm sash, insulation, weatherstripping, etc., a very important contribution to the war program can be made.

To assist Society members in their support of the government sponsored fuel conservation campaigns, the War Service Committee has prepared an outline of a meeting, which might be sponsored by Local Chapters of the Society as follows:

Fuel Conservation

Outline of Meeting to be sponsored by Local Chapters of the AMERICAN SOCIETY OF HEATING AND VENTILATING ENGINEERS
Prepared by War Service Committee

First Speaker—10 Minutes

(A) FUEL AS A VITAL WAR SUPPLY

(1) *Petroleum:* Amount of gasoline needed for mass bombing raids, tanks, jeeps, combat cars; Our seven ocean Navy is oil burning, etc. Railroad and tanker transportation and pipe lines must fill military requirements first.

(2) *Gas:* Used by busy war industries. Materials and manpower problems in the gas industry.

(3) *Coal:* Mining manpower must be conserved. Railroad transportation is critical. Gasoline, tires and trucks,—and manpower—for delivering coal to consumers is short. Supply to Allies and conquered countries.

(4) *Wood:* Supply available and areas of utilization of wood and waste products.

Second Speaker—15 Minutes

(B) WHY IT IS GOOD BUSINESS—WAR OR NO WAR —TO SAVE FUEL.

(1) Fuel costs *you* money.

(2) You are throwing *your* money away if you waste fuel.

(3) Size of the possible savings you can make. (For example, 14 per cent steam saving by using temperature control and investment paid off in 4.7 years, according to survey of 36 installations by *National District Heating Association* . . . Give other such examples.)

(4) Efficient operation is the No. 1 item of postwar planning for any business, according to numerous authorities. Competition will be keen after the war.

(5) Economical use of fuel oil enforced by rationing. Apply the same thinking that a fuel oil consumer must use to other fuels as well.

Third Speaker—20 Minutes

(C) CONSERVATION OF FUEL IN THE BOILER OR FURNACE ROOM.

(1) Adjust firing practices and methods to the fuel used. Since it may not be possible to secure just the kind and size of coal wanted this year, this factor is especially important in coal burning plants. Keep all fires clean.

(2) Check condition and operation of oil burner, gas burner, stoker or grates. Check the condition of the boiler and furnace. Keep all heat transfer surfaces clean.

(3) Check air supply and air controls. This includes breeching and stacks, ash pit and fire doors, dampers and fans. Excess air is the most common cause of heat waste up the chimney.

(4) Check boiler room instruments, thermometers, gages, meters, etc.

(5) Utilize waste heat for heating the building or hot water wherever possible.

(6) Utilizing all steam in the plant, starting to bank fires earlier toward the end of the day's run.

Fourth Speaker—20 Minutes

(D) HOW YOU CAN SAVE FUEL "UPSTAIRS."

(1) Assuming the heat value of the fuel has been efficiently transferred to the steam, water, or air which conveys the heat to where it is needed, that heat can still be wasted from the building.

(2) Condition of the building itself—insulation, storm sash, weatherstripping, calking, etc. Close off ventilators to attic and sub floor spaces in private dwellings.

(3) Too high temperatures carried? Heat turned on too early or off too late? Uneven heat distribution in the building, requiring overheating some spaces before others are at a minimum comfort level? Unnecessary spaces heated?

(4) Condition of the heating system. The piping or ducts. Radiation properly installed?

Fifth Speaker—15 Minutes

(E) HOW WE SAVED FUEL AT THE "ABC BUILDING."

(1) What we did to the building.

(2) What we did to the heating system.

(3) How we changed our operating methods.

(4) How much fuel we save in a year.

(5) The fuel saving in dollars or per cent of heating cost.

Questions and discussion from the audience.

How to Save Fuel and Keep Comfortable*

The function of a heating plant is not to warm the occupant of a room but to provide an environment in which the human body can *lose* or get rid of the heat which is generated within. To be able to lose heat exactly as fast as it is produced is an absolute necessity because otherwise the temperature of the body would rise and the normal processes and activities going on within the body would be hindered.

Human beings cannot store heat because the body temperature cannot be permitted to rise. It would be wonderful if it were possible to soak up heat all summer and use it as reserve heat supply in winter, but unfortunately the body temperature has to be maintained at 98.6 F at all times. A temperature rise of one degree will send a man to bed. A two-degree rise will send him to the doctor. A four or more degree rise may send him to the undertaker. The limit is 106 to 108 F, beyond which life cannot survive.

This 98.6 F temperature is interesting. Whether humans live in the Arctic or in Africa, there is no variation in this normal body temperature.

The human body and the heating plant have many points of similarity.

The fuels which are used in heating appliances consist of carbon, hydrogen, and combinations of them which we call hydro-carbons. In order to burn, these elements must combine with oxygen and, if enough oxygen is available and combustion is completed, the products will be water vapor and carbon dioxide.

Food taken into the body is composed of carbon and hydrogen as combustibles and other chemical elements. It has a heat value which is generally expressed in heat units (calories in the metric system and British thermal units in the English system). When the digestive and assimilative processes are complete the food is converted into body tissues which are oxidized (burned) to water vapor and carbon dioxide. The carbon dioxide is carried to the lungs to be expelled from the system.

Just as fuel burning in a heating appliance gives off heat, so does the fuel burned in the body. If a person sits quietly in a room of about 70 degrees temperature and does nothing, the heat generated within the normal body is about 400 heat units per hour; and the 400 heat units generated must be given off at once to the environment.

The rate of 400 heat units generated is a sort of minimum for no bodily activity when awake. Severe exertion may increase it 12 times to 4800 per hour. In between these limits the rate varies for typical activities as follows:

Typing rapidly	558
Walking 2 mph or dancing	761
Bowling	1500
Walking fast	2580
Walking upstairs	4365

The heat given off being equal to the heat generated makes the individual into a space heater which is about as good as 2 sq ft of steam radiator surface when sitting quietly and equal to a radiator of 20 sq ft when working very hard.

In order to regulate the temperature at 98.6 degrees the heat is given off in three ways which for the person sitting quietly would be distributed about as follows:

1. By radiation ... 200 heat units
2. By convection .. 100 heat units
3. By evaporation . 100 heat units

Radiation is the heat interchange which takes place between the body and clothing surface and the surrounding objects, such as walls, windows, ceiling, and floors. It travels directly across empty space or vacuum, and is, for example, familiarly recognized as the heat that impinges upon the face from the fire in the fireplace.

Convection is the carrying of heat by circulation of air. The air brushes against the body and if it is cooler than skin temperature, the air is warmed by contact. If air motion is increased by the use of a fan to move the air more heat is carried away and a feeling of coolness is experienced.

Evaporation is the change of water into vapor. A familiar example is the tea-kettle in which the flame under the kettle heats the water and changes it into steam. The tea-kettle cools the flame from which it obtains the heat. Moisture reaching the surface of the body changes into water vapor (steam at low pressure) and the heat to produce this change is taken from the skin surface. When sitting quietly in a comfortable environment, the individual is not aware of the normal evaporation of moisture. A dog which has no sweat glands cannot evaporate water from the skin and must blow air over a long tongue to increase cooling effect by evaporation. The movement of air increases the evaporation and cools the dog's tongue.

The complicated control mechanism within the body seeking to maintain a constant body temperature varies the rate of moisture evaporation most readily but also varies radiation and convection within rather narrow limits. Discomfort begins whenever the individual is conscious of the effort being made to maintain body temperature.

Oxygen and Carbon Dioxide

It was previously mentioned that oxygen is required for combustion which goes on in the body and that carbon dioxide is a product of combustion. Trees and plants can absorb carbon dioxide, but human beings must get rid of it. The lungs expel the carbon dioxide and draw in air which is a mixture of 80 per cent nitrogen and 20 per cent oxygen. As pure oxygen cannot be taken *straight* the nitrogen serves to dilute it. No one can hoard oxygen or even take more than necessary from the atmosphere. The lungs will operate only enough so that the concentration of carbon dioxide in the lungs is kept at 5 per cent.

Since an individual takes in and gives out only about 20 cu ft of air per hour and since the air given out contains only 5 per cent or a total of 1 cu ft carbon dioxide, it is obvious that one human being would have an extremely small ef-

*Outline of talk prepared for organizations interested in Fuel Conservation.

fect upon the carbon dioxide content of a room. In the average residence, normal infiltration and in-leakage changes the air once an hour and consequently an occupant in a room 10 ft by 10 ft by 7 ft would add only about ⅛ of one per cent carbon dioxide to the air. In home heating the carbon dioxide content can therefore be forgotten and it can be assumed that the air contains plenty of oxygen.

Carbon dioxide, which is harmless until it reaches a concentration that would have to reach 30 per cent to be fatal in a half hour should not be confused with carbon monoxide which is extremely dangerous. Six one-hundredths of one per cent carbon monoxide would produce a severe headache in an hour, and if present to the extent of ½ of one per cent, would be fatal in a half hour. Carbon monoxide is present in most manufactured gases and may also be generated by coal, oil, or gas fuel if combustion is not complete. Carbon monoxide has no odor. When one *smells gas* from any heating appliance, although the odor is not caused by carbon monoxide, it is very likely that carbon monoxide is present in dangerous quantity so the advice is *look out.*

A satisfactory amount of outside air for a home is the quantity which will eliminate cooking, laundry, smoking, or other odors. Odors do not indicate that the quality of air as far as the lungs are concerned is bad, but they do have a psychological effect upon the individual. These remarks are concerned with the *necessity* for outside air and are not intended to counteract the very commendable desire for plenty of invigorating outside air, which desire can be gratified when there is no need to save fuel.

Those who sleep in rooms having excessive ventilation in winter probably use so many blankets that the air has no opportunity to reach the body and further, the air may be so cold that the nose must be buried in the blankets instead of being able to take advantage of the available fresh air. At any rate one may be able to ventilate less than usual; especially at night, let the fresh air reach the body, be more comfortable, save heat, and be perfectly healthy.

Ventilation in places where people gather is entirely a different matter. In such cases, depending on the volume of space available per person, the outside air requirement will be 10 to 30 cu ft per person per minute. Again, however, it will be found that this is the amount of air required to prevent body and clothes odors from becoming objectionable.

Research work conducted by the American Society of Heating and Ventilating Engineers in its Research Laboratory at Pittsburgh and in other laboratories cooperating with the Society has demonstrated that comfort is affected by four items:

1. Air temperature
2. Humidity
3. Air Motion
4. Temperature of surroundings.

From a study of the effects of these items it has been possible to construct a chart from which the combined effect of the first three upon the normal individual can be predicted. Lower air temperature with higher humidity and lower air motion may produce the same feeling of comfort as higher air temperature, lower humidity, and more air motion. Such charts are known as comfort charts as they can be used to determine the probable reaction of individuals to the atmospheric conditions which are to be provided in any air conditioned space.

Air temperature alone does not at all determine whether a room is comfortable or not. A thermometer on a wall reads its own temperature only. It may be subject to the influence of a fireplace, radiator, lamp, hot or cold wall, and may be in a location having air circulation entirely different from the space surrounding the occupant.

Humidity in a home is likely to vary quite a lot with the activities in the home. Cooking, laundry, and showers add moisture. Infiltration of air will affect the moisture. Insulation, weatherstripping, and storm sash and vapor barriers in walls will reduce air leakage and will tend to increase the humidity as less air leakage will occur to carry out moisture. The physical effect upon the human individual of the range of moisture encountered in homes has not been determined except in regard to the feeling of comfort at various combinations of temperature, humidity, and air motion.

Air motion within homes is the result of currents set up by heating equipment such as radiators, convectors, flow and return openings of air ducts and reverse currents established by air coming in contact with cold walls and window surfaces. For comfort, warm air should circulate gently around occupants while cool air currents should be counteracted to prevent contact with occupants.

The temperature of surroundings, particularly of wall and window surfaces, exerts a definite influence upon comfort. As will be mentioned, hereafter, cold walls and windows make it necessary to use higher air temperatures than are necessary for equal comfort with warmer walls and warmer window surfaces. This is due to the increase in radiant heat loss from the occupant to the cold surface. Methods of increasing the surface temperature consist of insulating walls, installing storm sash and in certain systems heating the wall by water coils or air ducts within them. Warm air within the room may also be caused to flow along the walls and thereby raise the wall temperature. Radiators placed in properly selected places may radiate heat to occupants as well as serve to deflect downcoming cool currents from windows or cold walls.

Effective Temperature

The term *effective temperature* which is used in connection with comfort charts is an arbitrary index of the degree of warmth or coldness felt by the human body in response to temperature, humidity, and air motion. The numerical value given to it is obtained from the temperature of air saturated with moisture which will induce the identical feeling of warmth. For instance; in still air, a person at rest and normally clothed will feel equally warm if the room temperature is 70 F and the relative humidity is 50 per cent, as when the room temperature is 73.5 F and the relative humidity is 15 per cent. Both conditions fall on a diagonal line on the temperature chart marked 66

F, which also passes through the point of 66 F and 100 per cent relative humidity. Sixty-six is therefore the *effective temperature* for these conditions of environment.

In studying reactions of individuals under test conditions, it has been found that the *effective temperature*, at which 97 to 98 per cent of the people feel comfortable is 66 deg in winter and 71 deg in summer. Fifty per cent of the people will be comfortable in winter at effective temperatures between 63 and 71 F. In summer the range of effective temperature in which 50 per cent of the people will be comfortable will be 66 to 75 deg. Limits for relative humidity are shown as 30 per cent minimum to 70 per cent maximum on the comfort chart for both summer and winter comfort, but these are not absolute limits for comfort.

When the comfort requirements of individuals are understood, it is possible to evaluate all fuel saving suggestions in relation to their effect on comfort. Those improvements which add comfort in addition to saving fuel are obviously the most desirable changes to be considered. While statements are made that 65 deg air temperature in rooms has no harmful effect on health, there are so many factors such as wall temperatures, glass temperatures, air circulation, degree of activity, and physical condition of occupants, etc., which enter into consideration, that it is just about impossible to obtain proper facts on which to draw such a conclusion for general application. Undoubtedly the greater proportion of individuals would prefer to use less residence space in order to maintain comfortable temperatures in the space used particularly in living rooms.

Effect of Construction on Fuel Consumption

Great savings in fuel consumption can be made by improving building construction, and as such improvements not only add comfort, but yield dividends on the investment as long as the building is used, they should be given careful consideration by every home owner and any person responsible for the operation of a heating plant. Authorities in widely separated areas have studied the problem of fuel saving and the similarity of their findings are significant. Four are reported as follows:

For instance 50 to 65 per cent of the fuel may be saved by adding wall and ceiling insulation, weatherstripping and storm sash. Computations for a two-story, six-room residence and a four-room, one-story bungalow, reported in a new bulletin[1] published by the University of Minnesota, indicate savings, which are certainly interesting. The following savings are based upon buildings having none of the improvements as a basis for computations:

	Four-Room Bungalow	Six-Room Two-Story Residence
(1) Storm sash may save.	9.3	11.1
(2) Storm sash and weatherstripping	13.9	15.3
(3) 1-in. ceiling insulation, storm sash and weatherstripping	46.2	39.1
(4) 4-in. ceiling insulation, storm sash and weatherstripping	50.0	41.7
(5) 1-in. ceiling and wall insulation, storm sash and weatherstripping.	59.0	56.5
(6) 4-in. ceiling and wall insulation, storm sash and weatherstripping.	66.5	63.9

The savings shown are possible because the loss of heat from an average uninsulated residence as estimated in the bulletin mentioned is:

40 to 65 per cent through walls and roof
10 to 30 per cent by air leakage
20 to 35 per cent through glass and doors

Estimates for any building of the percentage of heat lost will, of course, vary with the type of material assumed as a basis for the computations.

Average figures for a two-story unattached typical frame residence as published by the War Service Committee of the ASHVE are:

30 per cent through side walls
26 per cent through windows and doors
20 per cent through air leakage
15 per cent through ceilings and roof
9 per cent through floors

Estimates of heat loss from the average house as given in a University of Illinois Bulletin[2] are as follows:

27 per cent through walls
30 per cent through doors and windows
27 per cent by air leakage through cracks around doors and windows

The National Bureau of Standards has published[3] the following table of fuel savings that can be made by improving building construction.

Approximate Fuel Savings in Dwelling Houses

(Expressed in percentage of fuel that would have been required for similar house without insulation or weatherstripping)

	Saving Per cent
No insulation, weatherstripped.	15 to 2
Same, with double (storm) windows	25 to 3
½ in. insulation, not weatherstripped	20 to 3
½ in. insulation, weatherstripped.	About 4
½ in. insulation, with double windows	About 5
1-in insulation, not weatherstripped	30 to 4
1-in. insulation, weatherstripped.	About 5
1-in. insulation, with double windows	About 6

(Expressed in percentage of fuel that would have been required for similar house without insulation, but with weatherstripping)

With double windows, no insulation	10 to 1
½ in. insulation only	25 to 3
½ in. insulation, with double windows	40 to 4
1-in. insulation only	35 to 4
1-in. insulation with double windows	50 to 5

Estimate of Savings Effected by Various Improvements

While a wide variation may be expected in the estimated saving of fuel for any single item of change because much will depend on the condition of the structure before improvements are made, it is safe to conclude that for changes properly made the savings indicated may be expected.

1. *Weatherstripping:* Five to 10 per cent.

2. *Storm Windows and Doors:* Ten to 25 per cent. Storm Doors alone may save: Two to 3 per cent.

3. *Insulation of Ceiling:* Ten to 25 per cent.

4. *Insulation of Walls:* Ten to 20 per cent.

5. *Reflective Radiator Shields:* A fuel saving of 6.5 per cent was obtained in the University of Illinois Research Residence by placing reflective insulation behind the radiators.

6. *Shades and Drapes:* Tight-fitting shades drawn when possible and drapes will save fuel by reduc-

[1]Conservation of Fuel, by F. B. Rowley, R. C Jordan, and C. E. Lund, University of Minnesota, Engineering Experiment Station Bulletin No. 20.

[2]Save Fuel for Victory, University of Illinois Bulletin, Engineering Experiment Station, Circular Series No. 47.

[3]Thermal Insulation of Buildings, National Bureau of Standards, Circular 37

ing the heat loss through the windows. The saving will depend on the extent to which the windows can be covered and the interest the occupant may take in keeping the shades drawn. A possible fuel saving of two to three per cent might be expected from this source. During periods when the sun shines all windows on the sunny side should, of course, be uncovered to permit the heat to enter.

7. *Painting Radiators:* The heat output of a radiator may be increased nearly 10 per cent if a change is made from a bronze paint to an oil paint. This is not a fuel saving because if a radiator gives out more heat, the boiler must supply more. The possibility of altering the heat output by use of the proper paint is interesting, however, as it can be used to vary the proportion of heat distributed to rooms.

8. *Redistribution of Heat:* Redistribution of heat can be used to improve comfort conditions through delivering a greater proportion of heat to the living rooms and less to rooms which can be used at lower temperatures. While air circulation does take place between rooms of different air temperatures, a fuel saving is possible through placing the heat where it is needed and not attempting to keep every part of the home at a uniform temperature. This applies particularly in reducing heat delivery to rooms which are easily overheated.

If houses were built with bedrooms on first floor and living rooms on upper floors, it would be possible to maintain cool bedrooms and warm living rooms. The cool air would remain in the lower part of the residence and any bedroom windows opened at night would not cool the other rooms.

In summer with this arrangement cool air would be drawn through the lower floor bedrooms by the flue action of the house if windows were open on both upper and lower floors.

A heavy blanket or insulated cover placed over radiators in bedrooms at night will reduce room temperature. This works well for radiators on a hot water system since some circulation of heat takes place in them even when valves are closed.

9. *Fireplaces:* Every fireplace should be equipped with a tight damper to prevent escape of heat when not in use. Many fireplaces are left with the damper open throughout the year, because the occupant does not know from the position of the damper handle whether it is open or not.

Fireplaces may be constructed to circulate air from the room over the back wall of the fireplace thereby adding to the heat delivered to the room. This arrangement not only improves the effectiveness of the fireplace, but may also save fuel by making it possible to supply from the fireplace all the heat needed during the early Fall and late Spring season.

10. *Lowering Room Temperature:* It has been estimated that each degree by which the maintained residence temperature is lowered will save three per cent of the fuel in a climate where the average winter temperature is 35 F. Overheating likewise increases the fuel bill by the same amount.

The effect of lowering the temperature at night from 10:00 p. m. to 5:30 a. m. to a setting of 60 F has been estimated to save from 5 to 10 per cent of the fuel. Careful attention to make certain that the temperature is lowered during periods of absence, or when occupants are moderately active, and a careful watch for doors which may be left open may readily increase the fuel saving.

11. *Hot Water Tank and Heater:* If domestic hot water is heated by the steam or water boiler and there is a control that keeps the water in the boiler from going below a certain minimum temperature, then this control should be set for the lowest satisfactory temperature that will keep the water in the tank about 140 deg. This is satisfactory for most home use, prevents scale formation and corrosion in heaters, and saves fuel. The heat loss from the storage tank and boiler may be reduced 20 per cent if the water in the tank has been kept at 175 deg and it is lowered to 140 deg. Insulation of the tank will also save fuel.

12. *Effect of Chimney Improvement:* Leaky and defective chimneys cause a waste of fuel particularly when burning solid fuel, because the fire does not burn properly nor does it respond when the dampers are operated. Consequently, fires go out or the operator has to shake the grates too vigorously in attempting to make the fire burn and much fuel may be lost through the grate. A good chimney prevents waste of fuel to the ashpit.

13. *Effect of Draft Regulator:* A draft regulator added to an oil burner installation not equipped with one, may save 10 to 15 per cent by preventing an excessive chimney draft from drawing cold air through the heater.

Effect of Building Improvement on Heating Plant

The improvement in construction discussed in previous paragraphs will reduce the load on the boiler or furnace. In many cases this will permit operation of the heater at a more efficient rate, particularly if the heater installed is somewhat smaller than it should be for the load.

The decrease in load may also make it possible to install baffles in the heater flues to improve the efficiency and may effect a fuel saving of 5 to 10 per cent.

Saving in Size of Heating Plant

If insulation is applied to ceilings and walls and windows are weatherstripped, and storm sash is provided in a new residence, the size of the heating plant will be reduced in proportion to the heat saved. This results in a great saving in cost of the heating plant, makes it more compact, and saves space in the basement.

Improvements in the Heater

Many heating plants would use less fuel if there were more heat-absorbing surface in the heater. Owners frequently insist on purchase of the smallest heater which will deliver the heat required. It is well known that a heater may be able to deliver the quantity of heat required without doing so efficiently. For this reason the purchaser should buy an efficient heater. It will yield dividends in fuel saving during the life of the heater.

Certain heaters can be made

more efficient by adding heat absorbing surface to that already installed. "Pancake" sections may be added, for instance, to many installed round boilers having only base, firepot, single and dome sections with a saving in fuel of 10 per cent.

Miscellaneous Suggestions

Attention to any of the following items will aid in saving fuel:

(1) All cracks and openings which allow air to enter the flues should be closed with putty or furnace cement or by replacement of warped or broken doors. Cold air entering the flues chills the gases and chimney and carries away heat.

(2) All flues should be kept clean by scraping or brushing. Dirty flues prevent the heat from reaching the absorbing surface.

(3) Defective, broken, or warped grates should be replaced. Fuel falling into the ashpit delivers no heat to the home.

(4) Insulation should be applied wherever heat escapes to unused space.

(5) Radiator valves and air valves should be examined to insure proper distribution of heat and to enable occupant to close off radiators in unused space.

Large systems could be modernized and show savings of from 15 per cent to 50 per cent.

All Improvements Affect Comfort

The improvements mentioned increase the comfort of the individual in addition to saving fuel.

Storm sash and weatherstripping raise the inside temperature of the glass from a value of 18 deg in zero weather to 42 deg. Less cold air falls to the floor and air temperatures along the floor are raised two to three degrees. Less dirt enters by in-leakage of air. The tendency to form condensation on windows is eliminated.

Ceiling and wall insulation raise the temperature of these surfaces. Frame walls which would have an inside temperature of 52 deg when the outside temperature is zero would reach a temperature of 68 deg. Consequently, the occupant loses less heat to the walls and therefore feels more comfortable. With 3 cold walls at 52 deg the air temperature would need to be 78 deg to produce comfort equal to that felt in a room having the walls at 68 F and an air temperature of 73 F.

Conclusion

The conclusion based upon the effect of the improvements suggested is that it is possible to save fuel and at the same time to be comfortable. It is also advisable to make these fuel saving changes because they will yield dividends as long as the building is in use.

Chapters Can Aid Local Service Clubs

In connection with the extensive government Conservation Program just announced jointly by Donald M. Nelson, Chairman WPB, Harold L. Ickes, Solid Fuels Administrator for War and Petroleum Administrator for War, and Joseph B. Eastman, Director, ODT, Local Chapters, as well as individual members of the Society, can be helpful in their local communities by giving proper unbiased advice on fuel problems, because there is great public interest in fuel burning whether it be coal, oil, gas or wood.

The government program to conserve critical resources as outlined, will fight waste and obtain savings in 7 industries by public participation and cooperation. War demands indicate that important savings must be made in Coal, Petroleum products, Gas, Electricity, Water, Communications, and Transportation, and in the materials, manpower and equipment required in their production and delivery.

An effort to interest service organizations and luncheon clubs in sponsoring a Fuel Conservation Week in October should be made at once.

An outline for a talk which might be suitable for such meetings as local Rotary, Kiwanis, Lions, Exchange, Women's Clubs, etc., has been prepared and can be adapted to meet local needs.

PAW SUSPENDS CONVERSIONS

The Petroleum Administration for War has announced suspension, for the time being, of its program for the conversion of industrial and commercial oil-burning equipment to the use of coal.

In making the announcement, Petroleum Administrator Harold L. Ickes said:

"We are suspending the program in view of the uncertainties in the coal situation, including the shortage of delivery equipment and manpower for retail coal delivery.

"No one should construe this suspension of the industrial and commercial conversion program as meaning that we are 'over the hump' as far as oil supplies are concerned. War developments might well make it necessary at some future time to resume the program, especially in view of the fact that we are still faced with an over all shortage of oil in the United States."

The PAW announcement emphasized that the suspension of conversion activity does not apply to conversions now in process, inasmuch as the supply program for the coming winter has been based upon the assumption that requirements will be reduced by the amount now used in these facilities.

Reviewing the conversion campaign to date, Deputy Administrator Ralph K. Davies pointed out that industrial conversions to date have resulted in savings equivalent to 176,500 barrels of fuel oil per day. Of this total, 137,155 barrels daily have been saved in the 17 eastern states and the District of Columbia, 30,034 barrels daily in the 15 middle western states, 3,566 barrels daily in the southwestern Gulf Coast States.

Mr. Davies said: "This conversion campaign has been a positive and substantial benefit to our domestic oil supply situation."

57 FUEL CONSERVATION REMINDERS

Compiled by American Society of Heating and Ventilating Engineers,
51 Madison Ave., New York

For the Heating System

1. Has oil burner, stoker, or gas burner been adjusted for correct combustion?
2. Is there a draft regulator on oil burner installation?
3. Is the smoke pipe between the heater and chimney tight and free of soot?
4. Has the chimney been inspected and cleaned?
5. Is boiler or furnace insulated?
6. Has insulation been added to hot water tank or heater?
7. Are basement pipes and ducts covered?
8. Are pipes and ducts running through unexcavated areas or unheated garages covered?
9. Are registers and air returns obstructed by furniture or drapes?
10. Do air valves permit free venting of air from radiators and piping?
11. Are there any leaking radiator traps?
12. Do radiator shut off valves leak steam to the room?
13. Do hot water faucets leak?
14. Are heavy blankets or insulated covers being used on hot water radiators in rooms that are closed off?
15. Is heat distributed evenly to the space being heated?
    a. Do the air supply ducts need balancing to improve distribution?
    b. Do any pipes need changing to balance distribution of steam or water?

For the Heat Generator

1. Can boiler or furnace efficiency be improved by adding heating surface?
2. Does the furnace or boiler have cracks or warped doors which let cold air into the flues?
3. Do the ashpit door and air inlet damper fit tight so the fire will really be checked when they are closed?
4. Are grates broken or warped so that fuel is wasted to the ashpit?
5. Have temperature limit controls been checked for adjustment and operation?
6. Are internal flues and passages of boiler and furnace clean?
7. Does the safety valve on steam boiler leak steam?

Efficient Operation

1. If you do not have a clock type thermostat, do you always set the temperature back to 60 deg before going to bed?
2. Do you always remember to set the thermostat back to 60 deg when you leave the house unoccupied for the day? Or to 50 deg if you are away for several days?
3. Do you carry a lower temperature (65 deg-68 deg) during day when occupants are active?
4. Do you carry a conservative temperature (70 deg-72 deg) during the evening hours?
5. Can you wear more clothing and use a lower room temperature?
6. Do you set your thermostat back when opening windows for airing the house?
7. During mild weather do you leave doors open without setting back your thermostat?
8. Do you close your registers or radiators at night in occupied bedrooms?
9. Do you keep your bedroom doors closed at night?
10. Do you open more than one bedroom window at night, or raise sash more than an inch in cold weather? Why?
11. If you have a playroom or laundry in basement, do you heat these areas when they are not being used?
12. If you operate a winter air conditioner, do you keep your filters clean?
13. Are you heating your sun room? Is it necessary?
14. Are you heating your garage? Why?
15. Do you always close the doors of the attached garage when you take the car out?
16. Do you close fireplace dampers as soon as practical after using the fireplace?
17. Do you keep the flues clean in the boiler or furnace?
18. Do you fire fuel according to instructions provided with the boiler or furnace?
19. Do you keep the ashpit clean to prevent overheating and warping of grates?
20. Do you take excessive quantities of outside air into your warm air system?

For the House

1. Have you insulated your roof?
2. Are your walls adequately insulated?
3. Have you any uninsulated floors over unheated areas?
4. Are all outside wall stud spaces closed at attic floor line?
5. Are all outside openings in your attic closed during the heating season?
6. Are there any cold drafts that come in around your windows which could be prevented by calking?
7. Do you have storm sash for ALL windows?
8. Are you using tight fitting storm doors on all outside doors?
9. Have you weatherstripped all outside doors and windows to reduce air infiltration?
10. Do inside doors leading to unheated areas seal tightly when closed? Have you closed off open stairways at the bottom?
11. Are you using in-a-door type seals under bedroom doors to prevent cold night air from circulating to other parts of the house?
12. Do you have fireplace dampers? Do they close tightly.
13. Is insulation installed behind those radiators which are placed on outside walls? Does it reflect heat back into the room?
14. Are the walls sealed at top of foundation to prevent cooling of cellar?
15. Have you a cold wall between garage and house that should be insulated?

Carbon Monoxide

THE FOLLOWING data regarding the occurrence and effect of carbon monoxide have been compiled in response to inquiries about this gas. While most of this information has been published in the ASHVE Transactions and elsewhere it is probable that this summary will be of value as a condensed reference on the subject.

The source of carbon monoxide is usually one of the following: escaping manufactured gas; incomplete combustion in appliances burning gas, oil, or solid fuel; and automobile exhaust. While carbon monoxide is odorless the incomplete combustion which causes it in burning gas fuel also produces aldehydes which are readily detected by the sense of smell. Carbon monoxide may be present although there is no odor, but if there is a slightly disagreeable odor it is certain that carbon monoxide is present in the flue gas products and exposure to them will be injurious to health.

In order to obtain approval of gas appliances submitted to the American Gas Association Laboratories, it is necessary that the carbon monoxide produced shall not exceed the following amounts:

For boilers, furnaces, water heaters, the concentration of carbon monoxide shall not be in excess of 0.04 of 1 per cent in an *air free* sample of flue gases, even though a gas pressure 50 per cent above normal is applied at the inlet of the appliance or gas pressure regulator and although the appliance is not connected to a chimney.

For space heaters and room heaters, the concentration of carbon monoxide shall not exceed 0.02 of 1 per cent in an *air free* sample of flue gases when the inlet gas pressure is 50 per cent above normal and when the appliance is not connected to a chimney.

In the development of the ventilation system for the Holland Tunnel, a number of tests were conducted by the U. S. Bureau of Mines, to determine what percentages of carbon monoxide would be found in the exhaust gases of automobiles and trucks.[1]

Based on tests of 101 vehicles, conclusions were drawn as follows:

1. Automobile exhaust gas consists of carbon dioxide (CO_2), carbon monoxide (CO), hydrogen (H_2), methane (CH_4), oxygen (O_2), nitrogen (N_2) and water vapor. The relative proportions of these constituents varies greatly in the exhaust from different motors, depending upon carburetor adjustment, degree of atomization, compression and other variable factors.

2. The important constituent of exhaust gas, as regards tunnel ventilation, is carbon monoxide (CO).

3. The CO found in the exhaust gas of the various industrial cars varied from 0.5 to 14.0 per cent.

4. The higher percentages of CO are produced when the throttle is nearly closed, as when running down grade or the car is standing and engine idling. The largest quantity of CO is produced when the gasoline consumption is greatest, as with cars accelerating or running upgrade at maximum speed.

From these tests and with the proposed number and types of vehicles using the tunnel at the specified speeds, it was calculated that the following quantities of CO would be produced in the tunnel:

On the up grades—0.118 cfm per foot of tunnel
On the down grades—0.05 cfm per foot of tunnel
On the level grades—0.09 cfm per foot of tunnel

[1]Development of the Ventilation System of the Holland Tunnel, by A. C. Davis. (ASHVE Transactions, Vol. 37, 1931.)

Based upon tests on individuals conducted at the U. S. Bureau of Mines' Experimental Station at Yale University,[2] the following conclusions were drawn regarding the gases to be found in automobile exhaust and their effect upon human beings:

1. Exhaust gas of automobiles contains no substance which is toxic to any appreciable extent, other than carbon monoxide.

2. Gasoline engines, with cylinders missing or when cold, may throw off disagreeable vapors irritating to the eyes and nauseating to some persons.

3. The physiological effects of carbon monoxide are wholly due to the union of this gas with the hemoglobin. To whatever extent the hemoglobin is so combined, by that amount it is rendered incapable of transporting oxygen to the organs and tissues of the body. The combination of CO and hemoglobin is a reversible reaction, so that when a person returns to fresh air the CO is gradually eliminated.

4. Of all physical signs and tests of CO poisoning, headache proved the most definite and reliable. Concentration of gas too weak or periods of exposure too short to induce this sign, are to be considered harmless.

In a paper[3] presented before the ASHVE an investigation in a 12-story garage was reported as follows:

One investigation on the 12-story garage showed that about 1,000 cars moved in or out of the garage during the rush period of two hours. The average time interval for parking the car or from the starting of the motor until the car leaves the building is about 2 min. The carbon monoxide exhausted was probably 1½ cu ft per car minute. This would mean that about 3,000 cu ft of CO was exhausted into the garage during the 2 hours, or an average of about 25 cfm.

Dr. Albert M. Stevens, Columbia University, New York, has drawn the following conclusions[4] regarding carbon monoxide:

CO is an unsatisfied, greedy combination, on the lookout for another molecule of oxygen. The CO molecule attaches itself to the oxygen bearing cells in the blood stream and will not be dislodged. It satisfies its voracious demand for additional oxygen at the expense of the tissues, and tissue asphyxiation results.

As to the amounts of the gas inhaled before any perceptible symptoms are produced, Dr. Stevens states that 3 parts of CO gas per 10,000

Table 1—Effects of Carbon Monoxide for a Given Time on Human Beings[5]

Concentrations of CO in Per Cent	Effect of CO in a Given Time		
	1 Hour	2 Hours	3 Hours
0.01	None	None	None
0.02	None	None	Slightly perceptible
0.03	None	Just perceptible	Headache and nausea
0.04	None	Headache	Headache and nausea
0.05	Slightly perceptible	Headache and nausea	Dangerous to life
0.06	Just perceptible	Headache and nausea	Dangerous to life

[5]Sayers, Meriwether and Yant confirm Dr. Henderson's data and give the results as shown in Table 2.

[2]Loc. Cit. Note 1.
[3]Airation Studies of Garages, by W. C. Randall and L. W. Leonhard. (ASHVE Transactions, Vol. 36, 1930.)
[4]Carbon Monoxide Poisoning in Young Children. (Heating, Piping and Air Conditioning, November, 1929).

Table 2—After Effects of Carbon Monoxide for a Given Time on Human Beings at Rest and Exercising Strenuously

Concentrations of CO in Per Cent	Subject at Rest				Subject Exercising Strenuously
	1 Hour	2 Hours	4 Hours	6 Hours	1 Hour
0.02	None	None	None	None	—
0.025	—	—	—	—	Very mild to moderate
0.03	—	—	Mild	Moderate	—
0.032	—	—	—	—	Mild to moderate
0.04	Moderate	—	—	—	Moderate

parts of air produce no appreciable effect. That is to say, the body is able to overcome any effects of poison in this amount. In proportions of 6 parts per 10,000 physiological disturbance becomes perceptible. That is, if the gas is inhaled in amounts above 3 parts per 10,000 of air, there results some degree of poisoning. A ratio of 8 parts per 10,000 is sufficient to cause headache and nausea in workers, and 15 parts per 10,000 constitute an industrial menace.

Certain susceptible individuals may show earlier and more severe symptoms than others. One does not become inured to even very small amounts of the poison, and recent experiments go to show that the breathing of air containing as little as one part of carbon monoxide per 10,000 parts of air over a period of 4 hours by a person sitting at rest and breathing quietly, produces the same effect as exposure to 4 parts of the gas for one hour.

The symptoms of chronic carbon monoxide poisoning in adults are, first of all, the occurrence of fatigue and muscular weakness; then headache, dullness, mental depression, poor memory, restricted fields of vision, ashy pallor, palpitation, irregularity of the heart, and, finally, nausea, vertigo, slowing of the pulse, dyspnea, dilatation of the veins of the neck, and increase in the globular elements in the blood, increasing torpor, death.

In an article[5] on carbon monoxide, Dr. Vandaveer of the American Gas Association Testing Laboratory, reported the findings of Dr. Yandell Henderson et al, as shown in Table 1.

From the foregoing, Dr. Vandaveer drew the following conclusions: These authorities apparently agree that there are no deleterious effects on the human system when exercising or at rest when breathing an atmosphere of 0.03 of one per cent for one hour. In whole numbers this means three parts of carbon monoxide in 10,000.

[5]Facts About Carbon Monoxide, by Dr. Vandaveer. (Gas Age-Record, January 15, 1927.)

DIRECTOR OF RESEARCH APPOINTED BY ASHVE

On October 1, C. Tasker entered upon his duties as Director of Research of the American Society of Heating and Ventilating Engineers, 51 Madison Ave., New York City. For the past 13 years Mr. Tasker has been a member of the staff of the Ontario Research Foundation and as senior research fellow has carried on many important investigations relating to fuels, and a variety of problems connected with heating and air conditioning.

C. Tasker

The selection of Mr. Tasker for the important assignment of carrying on the Society's Research program was made by the Committee on Research and unanimously approved by the Council of the Society. In announcing the appointment, Pres. M. F. Blankin said, "the Society is most fortunate in securing the services of Mr. Tasker to direct the research work of the Society as he is well qualified by training and experience," and C. M. Ashley, Chairman of the Committee on Research, said that the Committee believes that the administration of the new program presents a distinct opportunity for extending the scope and increasing the prestige of the Society's research work. In his acceptance of the appointment Mr. Tasker said, "I have a deep sense of the magnitude of the task before us but I have a firm conviction that with the cooperation and support of the membership, the technical and scientific side of the Society's activities shall continue to grow."

Mr. Tasker was born in Manchester, England, and graduated from the University of Manchester in 1923 with the degree of M. Sc. (Tech.). Until 1930, when he came to Canada, he was on the staff of the British Fuel Research Board. He became a member of the Society in 1935 and has served as a member of the Committee on Research, and of the following Technical Advisory Committees from 1936 to date: Fuels, Insulation, Physiological Reactions, Air Conditioning in Industry, and Sensations of Comfort. He was elected to Council in 1941 and resigned on taking up this appointment.

He has also been active in the Ontario Chapter, served on its Board of Governors, and was President for the 1941-42 season. He holds membership in the Institute of Fuels and the American Society of Metals and has been a frequent contributor to technical publications in the United States, Canada and England.

GOVERNMENT NEEDS LABORATORY MECHANICS

The U. S. Civil Service Commission is searching for Laboratory Mechanics for war work in the National Bureau of Standards, Washington, D. C., one of the principal research and testing laboratories of the Government.

These men are needed to do work connected with the construction, installation, assembly, maintenance, overhaul, repair, and operation of the following types of equipment: (1) Electronic, (2) Machine Shop, (3) Automotive, (4) Electrical, and (5) General.

In normal times, the Bureau develops working standards of measurement, quality, performance, and practice used in science, engineering, industry and commerce, and conducts the necessary tests and investigations in this connection. The requirements of war agencies and industry have brought problems of great variety to the Bureau including projects of a secret and confidential nature.

NOMINATIONS FOR 1944

Nominations for Officers and Council

The Nominating Committee appointed to select candidates for Officers of the Society for the coming year, 1944, submits the following list of nominees:

For President:
S. H. DOWNS, Kalamazoo, Mich.

For First Vice-President:
C.-E. A. WINSLOW, New Haven, Conn.

For Second Vice-President:
ALFRED J. OFFNER, New York, N. Y.

For Treasurer:
L. P. SAUNDERS, Lockport, N. Y.

For Members of the Council:

Three-Year Term

C. M. ASHLEY, Syracuse, N. Y.
L. T. AVERY, Cleveland, Ohio
L. E. SEELEY, New Haven, Conn.
G. D. WINANS, Detroit, Mich.

Respectfully submitted,

NOMINATING COMMITTEE,
CARL F. BOESTER, *Secretary.*

In accordance with the provisions of the Society's Constitution, By-Laws and Rules, ballots containing the names of the above candidates will be sent to the membership for voting upon prior to the Annual Meeting in January.

Art. B-VIII—Section 11. The Nominating Committee shall consist of one (1) member eligible to vote designated by each Chapter, or his alternate also appointed by the Chapter. The Secretary of each Chapter shall certify to the Secretary of the Society on or before January first the names of the member and alternate selected.

The Committee shall meet at the Annual Meeting of the Society at the call of the Secretary of the Society and shall effect its own organization and elect its own Chairman. At the Semi-Annual Meeting of the Society, if possible, the Nominating Committee shall select the nominees for the ensuing year for the offices of President, First Vice-President, Second Vice-President, Treasurer, and four (4) members of the Council. In any event the names of the nominees shall be certified to the Secretary of the Society before September twentieth, with the written consent of each nominee to fill the office for which he has been selected and their names with the offices to which they have been nominated shall be published in the October issue of the JOURNAL.

Art. B-IX—Section 2. The Secretary shall prepare ballots with the names of all candidates and forward them to the members, eligible to vote, at least thirty (30) days before the date of the Annual Meeting.

Nominations for Members of Committee on Research

Although committees of the Society are usually appointed, in view of the great importance of the Committee on Research and the financial responsibility it would be called upon to assume, it has been made more representative of the entire membership of the Society by a process of *election.* The election is governed by the By-Laws for the election of officers, with the single exception that Members of the Committee on Research are nominated by the Council instead of by a Nominating Committee.

In accordance with the Regulations for the Government of the Research Laboratory, the Council announces the nomination of the following members of the Committee for election to succeed those members whose present terms expire January, 1944.

Three-Year Term

C. M. ASHLEY, Syracuse, N. Y.
F. E. GIESECKE, College Station, Tex.
F. C. MCINTOSH, Pittsburgh, Pa.
G. L. TUVE, Cleveland, Ohio
T. H. URDAHL, Washington, D. C.

The regulations governing the nomination and election of members of the Committee on Research are as follows:

ARTICLE II—ORGANIZATION

Section 1. *Committee on Research*—There shall be a standing committee known as the Committee on Research, consisting of fifteen (15) members each serving for three (3) years and five (5) retiring each year. The outgoing Chairman if serving in that capacity during the last year of his three (3) year term on the Committee shall without election become an additional member of the Committee on Research for one (1) year.

(*a*) The Council shall nominate previous to July first of each year five (5) members to fill the vacancies of those retiring at the next Annual Meeting.

(*b*) The nominations made by the Council shall be published in the October issue of the Society's JOURNAL.

(*c*) Any ten (10) members of the Society eligible to vote may present to the Secretary over their signatures, the name of one (1) or more additional nominees for the Committee on Research, provided such name or names are presented at least sixty (60) days prior to the next Annual Meeting, and such additional nominations shall be placed on the ballot opposite the nominations made by the Council.

(*d*) The election shall otherwise conform to the regulations provided for the election of officers of the Society in the Constitution, By-Laws and Rules.

(*e*) Vacancies may be filled by the Council, such persons chosen by the Council to serve until a successor is elected at the next Annual Meeting.

The 1944 Nominees

For **President**—Sewell H. Downs, Kalamazoo, Mich., was born in New York, N. Y., on July 3, 1898, and received his early education in the schools of Riverhead, L. I., N. Y. He graduated

S. H. Downs

from Cornell University in 1922 with an M.E. degree, and immediately joined the Clarage Fan Co. as sales engineer. In 1925 he was made chief engineer of the company, which position he now holds.

In 1931 Mr. Downs joined the ASHVE and was elected as a member of Council in 1936, was Second Vice-President in 1942, and First Vice-President in 1943. He has served on numerous Council and Special Committees as follows: Chairman of Standards Committee, Meetings, Finance, Guide Publication Committee, Committee on Research, Committee on Ventilation of Garages and Bus Terminals, Committee on Air Distribution and Air Friction, Fan Test Code Committee, and the Joint Committee on Standards for Residence Heating.

Mr. Downs has been active in the Western Michigan Chapter of the ASHVE, serving on various committees, as president of the Chapter in 1934-35, and on the Board of Governors from 1935-36. He has also been active in the Michigan Engineering Society and other professional societies.

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For **First Vice-President**—C.-E. A. Winslow, New Haven, Conn., was born in Boston, February 4, 1877. He was graduated from the Massachusetts Institute of Technology, receiving his S.B. in 1898 and his S.M. in 1899, and in 1918 he was awarded an honorary degree of Doctor of Public Health (Dr.P.H.) from New York University.

Dr. Winslow taught in the department of Biology and Public Health at Massachusetts Institute of Technology from 1898-1910, at which time he became Associate Professor of Biology, College of the City of New York, which he held until 1915. From 1915 up to

C.-E. A. Winslow

the present he has been Professor of Public Health at Yale University.

He served as Chairman of the New York Commission on Ventilation from 1913-1923. In 1932 he became Director of the John B. Pierce Laboratory of Hygiene, New Haven, Conn.

Dr. Winslow has conducted researches and published numerous papers on relation of atmospheric conditions to human health and comfort, including ventilation. Besides being the author of numerous books on these subjects, he has presented many technical papers, which appear in the Society's Transactions, and is a frequent contributor to medical and health journals and other publications.

Since joining the Society in 1932, Dr. Winslow served as chairman and as a member of several Council Committees and many Research Technical Advisory Committees each year. For the past five years he has served as a member of the Committee on Research, serving on its Executive Committee in 1938, 1940 and 1942, as its Technical Adviser in 1939, and as its Vice-Chairman from 1940-42.

Dr. Winslow is also a member of many other associations, the American Bacteriologists, American Public Health Association, National Institute of Health, Academy of Arts and Sciences, Society of Experimental Biology and Medicine, American Society of Naturalists, New England Water Works Association and American Public Health Council, etc.

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For Second Vice-President—Alfred J. Offner, Consulting Engineer, New York, N. Y., was born June 24, 1888. He was educated in New York and holds degrees in B.S. and M.E. from Cooper Union, where he taught advanced physics for five years.

He spent six years as draftsman and engineer with Konrad Meier, Consulting Engineer, and five years as engineer with Henry C. Meyer, Jr., Consulting Engineer. In 1919 he became senior member of the firm of Offner and McKnight, Consulting Engineers.

Alfred J. Offner

In 1930 Mr. Offner opened his own office.

He was the consulting engineer for numerous government and private buildings located in various parts of the United States, also in Europe, South America and Asia.

Mr. Offner has taken an active part in the affairs of the New York Chapter, having served on the Board of Governors in 1928-29, and as its President in 1930. He was a member of the New York City Building Code Committee, and

a member of the Building Laws and Regulations Code Committee in 1929. In 1930-31 he served on the Professional Engineering Licensing Law Committee.

Mr. Offner has been a member of the Society's Council since 1935, and served as Treasurer of the Society from 1935 to 1938. He has been Chairman of the Admissions and Advancement Committee, and Chairman of the Regional Meetings Committee in 1938 and '39. He was a member of the Guide Publication Committee for three years being Chairman in 1942. He also served as Chairman of the Finance Committee in 1939 and '40, and as a member of the Executive Committee of the Council in 1941 and '42.

Mr. Offner has presented papers before the Society and has written numerous articles on the subject of heating and ventilation, and wrote the original chapter on hot water heating in the Society's Guide.

Besides being a member of the Society he is also a member of the New York Association of Consulting Engineers, serving as its president in 1936 and 1937.

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For Treasurer — Laurence P. Saunders, Chief Engineer of Research Engineering, Harrison Radiator Div., General Motors Corp., Lockport, N. Y., was born on June 24, 1891 at Stroud Green, London, England, and received his elementary training from private tutors in both England and the United States. He later attended Grammer and Westbourne Grove College in England.

In 1906 he entered the employ of Messrs. Legros and Knowles, London, automobile manufacturers, and from 1910-1914 he was connected with various U. S. and Canadian factories.

From 1914 to 1919 he served in the British Navy as an engineer on diesel engine craft. Following World War No. 1, Mr. Saunders joined General Motors Research Corp., Dayton, Ohio, and in 1920 he became associated with the Harrison Radiator Division of the Corporation, where he developed modern methods of car radiator testing in the laboratory.

He joined the Society in 1933 and served as treasurer, 2nd vice-president, 1st vice-president, and president of the Western New York Chapter from 1936-39. He served on several Chapter Committees, Membership, Nominating and Speakers, and as a member of several Research Technical Advisory Committees of the Society.

He was elected a member of the Council of the Society in 1941 for a three-year term, and is a member of the current Committee on Research serving a three-year term, as well as a member of the Special Committee on Chapter Relations. He is also Chairman of the Stand-

L. P. Saunders

ards Committee, and is a member of the Research Technical Advisory Committees on Corrosion, the Flow of Fluids Through Pipes and Fittings, and Air Distribution and Air Friction.

Mr. Saunders has written extensively on evaporative cooling, and radiator development and car cooling for SAE Journal; and on research and automotive progress for other automotive publications.

He holds membership in the Aero Club of Buffalo, American Society of Naval Engineers (civilian member), American Society of Refrigerating Engineers, Detroit Engineering Society, Institute of Automobile Engineers, Professional Engineers Society, Rochester Engineering, Society of Automotive Engineers, serving as a member of their National Nominating Committee and their Committee on Heat Exchangers for Aircraft A-7. He also served as a member of the National Advisory Committee for Aeronautics, as a member of the sub-committee on Heat Exchangers for Aircraft. Mr. Saunders is a member of the Cooperative Research Council serving on the sub-committees on Coolant Systems, as Chairman of sub-committee on High Pressure Radiator Design, and as a member of the New Coolant Liquids Committee.

Mr. Saunders is a member of the Rotary and Tuscarora Clubs of Lockport, and is chairman of the Boy Scout Troop Committee.

PRESIDENT BLANKIN ON COAL ADVISORY COUNCIL

OPA Ration Order No. 19, which became effective in 12 Eastern States September 1, affects deliveries of anthracite for use in space heating, domestic hot water, and domestic cooking.

Joel Dean, Director of Fuel Rationing Division, has announced the organization of a Coal Rationing Advisory Council with the following personnel: W. W. Bayfield, American Coal Sales Association, Washington, D. C.; Merrill F. Blankin, President, American Society of Heating and Ventilating Engineers, Philadelphia, Pa.; R. P. Botsch, The United Coal and Dock Co., Milwaukee, Wis.; E. M. Douthat, Sinclair Coal Co., Kansas City, Mo.; A. F. Duemler, Batchelder-Whittemore Coal Co., Boston, Mass.; Charles M. Farrar, Southeastern Retail Coal Association, Inc., Atlanta, Ga.; J. R. Maust, Maust Coal and Coke Co., New York, N. Y.; James L. Newbold, American Retail Coal Association, Washington, D. C.; Charles O'Neill, United Eastern Coal Sales Corp., New York, N. Y.; John Schreiber, Office of the Coordinator of the Retail Solid Fuel Industry of the City of New York; Roderick Stephens, Stephens Fuel Co., Inc., New York, N. Y.; C. W. Stone, Susquehanna Collieries, Philadelphia, Pa.; and R. P. Tibolt, New England Coke Co., Boston, Mass.

OPA ANNOUNCES CAST-IRON BOILER COMMITTEE PERSONNEL

Eight executives of companies engaged in the manufacture of cast-iron boilers and radiators were appointed recently by the Office of Price Administration to serve on its Cast-Iron Boiler and Radiator Industry Advisory Committee.

The purpose of the committee is to advise OPA on the industry's recommendations regarding Maximum Price Regulation 272, which sets maximum prices for cast-iron boilers and radiators. Those appointed to the committee are as follows: V. A. Good, Sales Mgr.,

Burnham Boiler Corp., Irvington, N. Y.; R. P. Henderson, Vice-Pres. in Charge of Sales, U. S. Radiator Corp., Detroit, Mich.; L. N. Hunter, Vice-Pres., National Radiator Co., Johnstown, Pa.; I. L. Jones, Pres., International Heater Co., Utica, N. Y.; M. D. Rose, Asst. Gen. Sales Mgr., American Radiator and Standard Sanitary Corp., Pittsburgh, Pa.; Carl Sawade, Mgr., Utica Radiator Co., Utica, N. Y.; S. K. Smith, Vice-Pres., The H. B. Smith Co., Westfield, Mass.; and W. R. Stockwell, Mgr., Mfg. Div., Weil-McLain Co., Michigan City, Ind.

U. S. MAY IMPORT OIL

Unless new oil fields are found, the United States may be forced to import oil from abroad and also use more coal of low grade for power generation, E. G. Bailey, Vice-President, Babcock and Wilcox Co., New York, warned the members of the American Society of Mechanical Engineers and the Engineering Institute of Canada at the opening of their joint meeting at Toronto, September 30. Mr. Bailey's paper stressed the fact that this war has brought into bold relief the true situation of the reservoirs of our basic fuel supplies. For years, many companies have blissfully developed power and heating equipment which required the use of high grade fuel without giving too much consideration of the long range welfare of their customers and the nation, regarding the reliability of the supply and the probable price of the necessary fuel. The petroleum industry balanced its production in the most advantageous way so long as it could find a market for residual oil at a price competitive with coal.

For a long time it has been evident to many engineers that fuel-burning equipment should be installed to use either coal or oil in certain geographical areas.

Unless substantial discoveries are made, we may shortly be forced to import oil from abroad, and probably also make it from coal and oil shale. Any source of additional oil supply will probably result in a sufficient increase in the price of petroleum products to cause a long time readjustment of the relative economies of oil and coal for many uses in some parts of the country.

OPA AMENDS ANTHRACITE ORDER

To encourage consumers to use rice anthracite, a small size coal, in place of the scarcer, larger sizes, the Office of Price Administration removed it from the limitation order affecting deliveries of anthracite in the eastern area effective Sept. 25.

There is a relative surplus of the smaller sizes of anthracite, including rice (No. 2 Buckwheat), which is over-burdening the storage capacities of coal mines. To facilitate mine delivery of the larger sizes, it has been found necessary to speed the movement of the smaller sizes.

Customarily rice anthracite has not been a popular size coal for the average consumer who has preferred egg, stove and nut (the larger sizes). With a comparatively greater shortage existing in these larger sizes, however, an effort is being made to encourage consumer use of rice and the smaller sizes. Rice anthracite can be used most efficiently with blower equipment.

Candidates for Membership

The Constitution of the Society, as now amended, requires the following mode of procedure in voting on applicants for membership in the Society. All applications for membership are to be sent to the Secretary and the names of applicants and their references shall be printed in the next issue of the Journal of the Society or sent to the members in other approved manner as ordered by the Council. When replies are received from references, the Candidate's application shall be submitted to and acted upon by the Committee on Admission and Advancement as soon as possible.

When the Committee on Admission and Advancement has acted favorably upon a Candidate's application and assigned his grade, the Council shall vote upon the election of the proposed Candidate for membership by letter ballot. During the past month 23 applications for membership have been received and the names of these men and their sponsors are published in the following list.

Members are requested to scrutinize the list with care. The Committee on Admission and Advancement, and in turn, the Council, urge the members to assume their share of responsibility of receiving these candidates into membership by advising the Secretary promptly of any whose eligibility for membership is in any way questioned.

All correspondence in regard to such matters is strictly confidential, and is solely for the good of the Society, which it is the duty of every member to promote.

Unless objection is made by some member by October 15, 1943, these candidates will be balloted upon by the Council. Those elected to membership will be notified by the Secretary immediately after election.

CANDIDATES	REFERENCES	
	Proposers	*Seconders*
ACKERMANN, REYNOLD H., Consulting Engr., Charles S. Leopold, Philadelphia, Pa.	F. H. Buzzard C. S. Leopold	H. B. Hedges F. J. Berlet, Jr.
ASH, ROBERT S., LT. (jg), Ass't to Public Works Officer, U. S. Naval Training Station, Great Lakes, Ill. (*Advancement*)	N. P. Fenner F. H. Gaylord	A. B. Martin William Bishop
BOOKER, JACK W., Design Engr., Westinghouse Electric Co., Pittsburgh, Pa.	F. C. McIntosh E. C. Smyers	H. L. Moore T. F. Rockwell
BURKES, LLOYD C., Mgr., Barber-Colman Co., Rockford, Ill.	C. Z. Adams Arvin Page	F. J. Reed K. W. Selden, Jr.
COX, EDWARD H., Vice-Pres. and Buffalo Mgr., Genesee Heating Service, Inc., Buffalo, N. Y.	M. C. Beman B. C. Candee	S. M. Quackenbush J. J. Landers

ECKHARDT, ELROY, JR., Partner, James F. O'Neil Plbg. & Htg. Co., New Orleans, La.	J. J. Joyce L. V. Cressy	John Devlin C. E. Brindell
FARNES, BERT W., Owner, B. W. Farnes Co., Portland, Ore. (*Advancement*)	G. H. Risley J. A. Freeman	E. H. Langdon T. C. Langdon
FREIJE, W. F., Engr., Hayes Brothers, Inc., Indianapolis, Ind.	J. G. Hayes G. B. Supple	S. E. Fenstermaker W. C. Bevington
GROOM, JOHN W., JR., Elec. Draftsman, Pan American Airways, Inc., Miami, Fla.	E. J. Long *A. D. Burroughs	*Emeric Gara *B. D. Richmond
HINNANT, CLARENCE H., JR., Capt., Corps of Engineers, Ft. George G. Meade, Md. (*Advancement*)	J. J. Burke J. A. Johnston	E. C. Wiley J. A. Wilson
LEAS, NAT N., Western Air & Refrigeration Co., Inc., Los Angeles, Calif.	W. W. Stuart J. H. Park	C. W. Helstrom J. T. Hansen
LOESER, CHESTER M., Secy., Elizabeth Cornice Works, Inc., Elizabeth, N. J.	J. A. Nicols Ludwig Mack	G. P. Dickson J. E. Matthews
MARTIN, HAROLD L., Htg. & Vtg. Engr., Kaighin & Hughes, Houston, Tex.	A. M. Chase, Jr. J. A. Walsh	H. U. Bible R. B. Johnson
MAYLARD, JOHN B., Ass't Regional Reconditioning Supv., Home Owners Loan Corp., Wilmette, Ill.	J. S. Kearney M. J. Bamond	R. O. Nelson C. H. Bevington
MCBRIDE, JOSEPH A., Ass't Sec., Frank A. McBride Co., Paterson, N. J.	J. N. McBride Joe Wheeler, Jr.	M. F. Rather P. G. Griess
MILLER, FREDERICK T. J., Hurst Oil Co., Norfolk, Va.	N. J. Helwick W. H. Dudley, Jr.	F. P. Fischer L. V. Cressy
MILLS, DOREMUS L., Research Engr., Revere Copper & Brass, Inc., Rome, N. Y.	W. L. Lynch O. O. Oaks	W. E. Heibel H. W. Fiedler
MINER, H. HARVEY, Partner, Miner Supply Co., Red Bank, N. J. (*Advancement*)	A. H. Schroth J. L. Lehman	I. E. Brex R. P. Strevell
ROCHE, AUSTIN O., JR., Mgr. of Mfg., Hoffman Specialty Co., Indianapolis, Ind.	Potter Bowles M. F. Blankin	W. A. Russell E. N. Sanbern
SCOTT, E. E., Representative, Ohio Injector Co., Wadsworth, Ohio.	DeWitt M. Allen W. A. Russell	F. H. Gaylord C. E. Pullum
SLEISTER, PARK E., Consulting Mechanic, Fremont, Nebr.	G. E. Merwin W. R. White	E. F. Adams B. G. Peterson
SMITH, RUSSELL J., Mfrs. Rep., Richmond Heights, Mo. (*Reinstatement and Advancement*)	Geo. Myers E. E. Carlson	J. W. Cooper L. W. Moon
WILLIAMS, GARLAND E., Sr. Engrg. Draftsman, Hull Drafting Room, Norfolk Navy Yard, Portsmouth, Va.	F. M. Brewer Irwin Rosenberg	C. M. Sterne J. C. Davidson

*Non-member.

Candidates Elected

In the past issues of the Journal of the Society the names of the following men were listed as Candidates for Membership. The membership grade of each Candidate has been assigned by the Committee on Admission and Advancement and balloted upon by the Council. We are now instructed by the Council to post herewith, as required by Art. B-III, Sec. 8, of the By-Laws, the following list of candidates elected:

MEMBERS

ADDAMS, PAUL K., Execuive Vice-Pres. & Treas. Fitzgibbons Boiler Co., Inc., New York, N. Y.

BERMEL, A. H., Chief Mech. Estimating Engr., August Arace & Sons, Inc., Elizabeth, N. J. (*Advancement*)

BOOT, ARTHUR, Mgr., Boot & Co., Inc., Grand Rapids, Mich. (*Reinstatement*)

FARRELL, EDWARD J., Partner, Farrell & White, Detroit, Mich.

MARTIN, WILLIAM T., Ch. Engr., Beech-Nut Packing Co., Canajoharie, N. Y.

NIESKE, GEO. F., Supt. of Construction, C. N. Flagg & Co., Inc., Meriden, Conn.

ROSEBROUGH, J. STODDARD, Sales Engr., L. J. Mueller Furnace Co., St. Louis, Mo. (*Advancement*)

SCHWARZ, GEORGE C., Gen. Mgr., Thos. J. Sheehan Co., St. Louis, Mo.

SCOTT, CLARENCE E., Mgr., Industrial Heating and Refrigeration Divisions of Fedders Mfg. Co., Inc., Buffalo, N. Y. (*Reinstatement and Advancement*)

SHEPSTONE, OSCAR, Mech. Engr., 4645 Devonshire Rd., Detroit, Mich. (*Reinstatement*)

SMITH, LAWRENCE J., Dir. of Research, Bell & Gossett Co., Morton Grove, Ill. (*Advancement*)

THOMAS, FRANK M., District Sales Mgr., Oklahoma Natural Gas Co., Enid, Okla.

WARREN, CLARENCE N., Vice Pres. and Ass't Mgr., Hayes Brothers, Inc., Indianapolis, Ind. (*Reinstatement*)

ASSOCIATES

COULTER, THOMAS H., Secretary, Vermiculite Research Institute, Chicago, Ill.

ELSIE, ROBERT L., Purchasing Agent, Atlas Engineering & Machine Co., Ltd., Toronto, Ont., Canada.

HALT, HOWARD R., Office Mgr., Thos. J. Sheehan Co., St. Louis, Mo.

LONG, D. A., Sales Engr., Trane Co. of Canada, Ltd., Toronto, Ont., Canada.

PIZER, M. MORTON, Engr., Daniel-Morris Co., Inc., New York, N. Y.

RUBEL, HARRY L., Owner, Rubel & Jensen Co., Newark, N. J.

STALB, J. G., Manufacturer's Agent, Brooklyn, N. Y. (*Reinstatement*)

JUNIOR

NEILANS, J. L., Draftsman, Trane Company of Canada, Ltd., Toronto, Ont., Canada.

Officers

President.....M. F. BLANKIN
First Vice-President.....S. H. DOWNS
Second Vice-President.....C.-E. A. WINSLOW
Treasurer.....E. K. CAMPBELL
Secretary.....A. V. HUTCHINSON
Technical Secretary.....CARL H. FLINK

Council

M. F. BLANKIN, *Chairman* S. H. DOWNS, *Vice-Chairman*

Three Years: J. F. COLLINS, JR., JAMES HOLT, E. N. MCDONNELL, T. H. URDAHL.

Two Years: L. G. MILLER, A. J. OFFNER, A. E. STACEY, JR., B. M. WOODS.

One Year: E. O. EASTWOOD, A. P. KRATZ, W. A. RUSSELL, L. P. SAUNDERS, C. TASKER.

Council Committees

Executive—E. O. Eastwood, *Chairman;* A. P. Kratz, E. N. McDonnell

Finance—J. F. Collins, Jr., *Chairman;* C.-E. A. Winslow, B. M. Woods.

Membership—E. K. Campbell, *Chairman;* A. J. Offner, W. A. Russell.

Meetings—S. H. Downs, *Chairman;* James Holt, C. Tasker.

Standards—L. P. Saunders, *Chairman;* L. G. Miller, T. H. Urdahl.

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Advisory Council

E. O. Eastwood, *Chairman;* Homer Addams, D. S. Boyden, W. H. Carrier, S. E. Dibble, W. H. Driscoll, W. L. Fleisher, H. P. Gant, F. E. Giesecke, E. Holt Gurney, L. A. Harding, H. M. Hart, C. V. Haynes, E. Vernon Hill, John Howatt, W. T. Jones, D. D. Kimball, G. L. Larson, S. R. Lewis, Thornton Lewis, J. F. McIntire, F. B. Rowley and A. C. Willard.

Special Committees

Admission and Advancement: E. P. Heckel, *Chairman (one year);* T. T. Tucker *(two years);* H. Berkley Hedges *(three years).*

ASHVE-ASTM-ASRE-NRC Committee on Thermal Conductivity—F. C. Houghten, *Chairman;* C. B. Bradley, H. C. Dickinson, R. H. Heilman, E. R. Queer, F. B. Rowley, T. S. Taylor, G. B. Wilkes.

ASHVE-IES Joint Committee on Lighting and Air Conditioning—H. M. Sharp, *Chairman;* W. R. Beach, B. C. Candee, W. G. Darley, C. L. Kribs, Jr., P. M. Rutherford, Jr.

Chapter Relations—J. F. Collins, Jr., *Chairman;* L. P. Saunders, H. E. Sproull.

Constitution and By-Laws—L. T. Avery, *Chairman;* M. W. Bishop, R. A. Miller.

F. Paul Anderson Award—S. H. Downs, *Chairman;* Tom Brown, F. E. Giesecke, L. L. Lewis and F. B. Rowley.

Guide Publication—P. D. Close, *Chairman;* Thomas Chester, John James, S. Konzo, C. S. Leopold.

Publication—C. H. B. Hotchkiss, *Chairman (one year);* J. H. Walker *(two years);* L. E. Seeley *(three years).*

War Service—John Howatt, *Chairman;* W. H. Driscoll, E. N. McDonnell, L. E. Seeley, B. M. Woods.

Nominating Committee

Chapter	*Representative*	*Alternate*
Atlanta	T. T. Tucker	L. F. Kent
Cincinnati	M. E. Mathewson	E. W. McNamee
Connecticut	L. E. Seeley	H. E. Adams
Delta	G. E. May	G. C. Kerr
Golden Gate	B. M. Woods	
Illinois	E. M. Mittendorff	A. O. May
Iowa	F. E. Triggs	C. W. Helstrom
Kansas City	L. T. Mart	M. M. Rivard
Manitoba	Ivan McDonald	Einar Anderson
Massachusetts	E. G. Carrier	A. C. Bartlett
Michigan	M. B. Shea	S. S. Sanford
Minnesota	R. E. Backstrom	William McNamara
Montreal	G. P. Ste-Marie	R. R. Noyes
New York	H. H. Bond	C. S. Koehler
Nebraska	B. G. Peterson	W. R. White
North Carolina	F. E. P. Klages	Arvin Page
North Texas	T. H. Anspacher	
Oklahoma	E. T. P. Ellingson	E. F. Dawson
Ontario	V. J. Jenkinson	H. R. Roth
Oregon	B. V. Farnes	
Pacific Northwest	R. D. Morse	E. H. Langdon
Philadelphia	H. H. Mather	Edwin E. Iliot
Pittsburgh	E. C. Smyers	E. H. Riesmeyer, Jr.
St. Louis	C. F. Boester	M. F. Carlock
South Texas	J. A. Walsh	A. J. Rummel
Southern California	W. O. Stewart	Leo Hungerford
Washington, D. C.	J. W. Markert	F. A. Leser
Western Michigan	T. D. Stafford	L. G. Miller
Western New York	H. C. Schafer	S. M. Quackenbush
Wisconsin	C. H. Randolph	Ernest Szekely

Officers of Local Chapters

Atlanta: Organized, 1937. Headquarters, Atlanta, Ga. Meets, First Monday. President, A. H. Koch, 3687 Peachtree Rd. Secretary, L. F. Lawrence, Jr., 304-101 Marietta St., Atlanta 3. **Cincinnati:** Organized, 1932. Headquarters, Cincinnati, O. Meets, Second Tuesday. Honorary President, Capt. C. E. Hust. President, Albert Buenger, Hotel Gibson. Secretary, E. J. Richard, 2137 Reading Rd., Cincinnati 2. **Connecticut:** Organized, 1940. Headquarters, New Haven, Conn. President, C. J. Lyons, Wilson Ave., S. Norwalk. Secretary, J. R. Smak, 160 Morehouse Highway, Fairfield. **Delta:** Organized, 1939. Headquarters, New Orleans, La. Meets, Second Tuesday. President, L. V. Cressy, 423 Baronne St., New Orleans 13. Secretary, J. S. Burke, 317 Baronne St., New Orleans 9. **Golden Gate:** Organized, 1937. Headquarters, San Francisco, Calif. Meets, First Wednesday. President, R. A. Folsom, 150 Hooper St. Secretary, R. B. Holland, 1275 Folsom St. **Illinois:** Organized, 1906. Headquarters, Chicago, Ill. Meets, Second Monday. President, Chas. E. Price, Room 1605, 6 N. Michigan Ave., Chicago 2. Secretary, C. M. Burnam, Jr., Room 1605, 6 N. Michigan Ave., Chicago 2. **Indiana:** Organized, 1943. Headquarters, Indianapolis, Ind. President, S. E. Fenstermaker, 937 Architects and Builders Bldg. Secretary, C. W. Stewart, 1001 York St.

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Iowa: Organized, 1940. Headquarters, Des Moines, Ia. Meets, Second Tuesday. President, C. W. Helstrom, 1614 Thompson. Secretary, B. E. Landes, 1603 47th St., Des Moines 10. **Kansas City:** Organized, 1917. Headquarters, Kansas City, Mo. Meets, Second Monday. President, L. T. Mart, 3001 Fairfax Rd., Kansas City, Kans. Secretary, F. S. Pexton, 824 Grand Ave., Kansas City 13, Mo. **Manitoba:** Organized, 1935. Headquarters, Winnipeg, Man. Meets, Third Thursday. President, F. L. Chester, 179 Bannatyne Ave. Secretary, F. T. Ball, 810 9th Ave., W., Calgary, Alta. Acting Secretary, Einar Anderson, 152 Bannerman Ave., Winnipeg. **Massachusetts:** Organized, 1912. Headquarters, Boston, Mass. Meets, Third Tuesday. President, E. G. Carrier, 704 Statler Bldg. Secretary, R. T. Kern, 51 Claflin St., Leominster. **Michigan:** Organized, 1916. Headquarters, Detroit, Mich. Meets, First Monday after 10th of month. President, S. S. Sanford, 2000 Second Ave. Secretary, A. E. Knibb, 1003 Maryland Ave., Detroit 30. **Minnesota:** Organized, 1918. Headquarters, Minneapolis, Minn. Meets, First Monday. President, D. B. Anderson, 1999 Pinehurst Ave., St. Paul. Secretary, A. W. Schultz, 240 Seventh Ave., S., Minneapolis.

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Montreal: Organized 1936. Headquarters, Montreal, Que. Meets Third Monday. President, F. A. Hamlet, 1010 St. Catherine St., W. Secretary, R. R. Noyes, 630 Dorchester St., W. **Nebraska:** Organized, 1940. Headquarters, Omaha. Meets, Second Tuesday. President, G. E. Merwin, 5012 Parker St., Secretary E. F. Adams, 1227 So. 52nd St. **New York:** Organized, 1911. Headquarters, New York, N. Y. Meets, Third Monday. President, R. A. Wasson, 500 Fifth Ave. Secretary, P. G. Griess, 189 Walnut Ave., Bogota, N. J. **North Carolina:** Organized, 1939. Headquarters, Durham, N. C. Meets, Quarterly. President, F. J. Reed, 263 College Station. Secretary, C. Z. Adams, 312 Piedmont Bldg., Greensboro. **North Texas:** Organized, 1938. Headquarters, Dallas, Tex. Meets, Second Monday. President, M. L. Brown, 3500 Commerce St. Secretary, E. T. Gessell, Thomas Bldg. **Northern Ohio:** Organized, 1916. Headquarters, Cleveland, O. Meets, Second Monday. President, P. D. Gayman, 2142 E. 19th St. Secretary, G. B. Priester, Case School of Applied Science, Cleveland 6.

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Oklahoma: Organized, 1935. Headquarters, Oklahoma City, Okla. Meets, Second Monday. President, E. F. Dawson, University of Oklahoma, Norman. Secretary, E. T. P. Ellingson, 314 Savings Bldg., Oklahoma City 2. **Ontario:** Organized, 1922. Headquarters, Toronto, Ont. Meets, First Monday. President, W. C. Kelly, 602 King St., W. Secretary, H. R. Roth, 57 Bloor St., W. **Oregon:** Organized, 1939. Headquarters, Portland, Ore. Meets, Thursday after First Tuesday. President, J. A. Freeman, 1623 S. E. 11th Ave. Secretary, G. H. Risley, 516 S. W. Oak St., Portland 4. **Pacific Northwest:** Organized, 1928. Headquarters, Seattle, Wash. Meets, Second Tuesday. President, R. D. Morse, 4404 White Bldg. Secretary, J. D. Sparks, 7331 W. Green Lake Way, Seattle 3. **Philadelphia:** Organized, 1916. Headquarters, Philadelphia, Pa. Meets, Second Thursday. President, Edwin Elliot, 560 N. 16th St. Secretary, E. H. Dafter, Room 2211, 12 S. 12th St., Philadelphia 7. **Pittsburgh:** Organized, 1919. Headquarters, Pittsburgh, Pa. Meets, Second Monday. President, G. G. Waters, 1841 Oliver Bldg. Secretary, E. H. Riesmeyer, Jr., 231-33 Water St., Pittsburgh 22.

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St. Louis: Organized, 1918. Headquarters, St. Louis, Mo. Meets, First Tuesday. President, C. F. Boester, 101 E. Essex, Kirkwood. Secretary, B. C. Simons, Rm. 706, 4030 Chouteau, St. Louis 10. **South Texas:** Organized, 1938. Headquarters, Houston, Texas. Meets, Third Friday. President, A. M. Chase, Jr., Box 359. Secretary, A. F. Barnes, 602 Kirby Bldg., Houston 2. **Southern California:** Organized, 1930. Headquarters, Los Angeles, Calif. Meets, Second Wednesday. President, W. O. Stewart, 153 W. Avenue 34. Secretary, Maron Kennedy, 5051 Santa Fe Ave. **Washington, D. C.:** Organized, 1935. Headquarters, Washington, D. C. Meets, Second Wednesday. President, S. L. Gregg, 4828 Edgemoor Lane, Bethesda, Md. Secretary, A. S. Gates, Jr., 111 County Rd., Kensington, Md. **Western Michigan:** Organized, 1931. Headquarters, Grand Rapids, Mich. Meets, Second Monday. President, C. H. Pesterfield, Michigan State College, East Lansing. Secretary, V. H. Hill, 2111 Colvin Court, Lansing 10. **Western New York:** Organized, 1919. Headquarters, Buffalo, N. Y. Meets, Second Monday. President, S. M. Quackenbush, 117 W. Tupper St. Secretary, Herman Seelbach, Jr., 45 Allen St. **Wisconsin:** Organized, 1922. Headquarters, Milwaukee, Wis. Meets, Third Monday. President, F. W. Goldsmith, 513 E. Day Ave. Secretary, E. W. Gifford, 611 N. Broadway.

Committee on Research

C. M. ASHLEY, *Chairman*

H. J. ROSE, *Vice-Chairman*

C. M. HUMPHREYS, *Acting Director*

J. H. WALKER, *Technical Adviser*

A. C. FIELDNER, *Ex-Officio Member*

Three Years: H. J. ROSE, L. P. SAUNDERS, L. E. SEELEY, A. E. STACEY, JR., C. TASKER.

Two Years: C. F. BOESTER, JOHN A. GOFF, W. E. HEIBEL, C. A. MCKEEMAN, C.-E. A. WINSLOW.

One Year: C. M. ASHLEY, M. K. FAHNESTOCK, H. KING MCCAIN, F. C. MCINTOSH, T. H. URDAHL.

Executive Committee: C. M. ASHLEY, *Chairman;* F. C. MCINTOSH, M. K. FAHNESTOCK, H. J. ROSE, T. H. URDAHL.

Finance Committee: E. N. MCDONNELL, *Chairman.*

U. S. GOVERNMENT PROGRAM
"PREPARE FOR WINTER"

1. **Order coal.**
2. **Order fuel oil now.**
3. **Save household gas.**
4. **Winter-proof your home.**
5. **Operate heating plant correctly.**
6. **Don't overheat**

Technical Advisory Committees

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16. *Flow of Fluids Through Pipes and Fittings:* F. E. Giesecke, *Chairman;* T. M. Dugan, S. R. Lewis, L. P. Saunders.*

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22. *Heavy Duty Air Heating Furnaces:* E. K. Campbell, *Chairman;* H. D. Campbell, K. T. Davis, A. P. Kratz, W. J. MacGirl, A. A. Olson, B. B. Reilly, H. J. Rose,* H. A. Soper.

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